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USER REQUIREMENTS FOR AERODROME MAPPING INFORMATION

RTCA/DO-272
October 12, 2001

Prepared by SC-193

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FOREWORD

This report was prepared by RTCA Special Committee 193 (SC-193) and EUROCAE Working Group 44 (WG-44) and approved by the RTCA Program Management Committee (PMC) on October 12, 2001.

RTCA, Incorporated is a not-for-profit corporation formed to advance the art and science of aviation and aviation electronic systems for the benefit of the public. The organization functions as a Federal Advisory Committee and develops consensus-based recommendations on contemporary aviation issues. RTCA's objectives include but are not limited to:

- coalescing aviation system user and provider technical requirements in a manner that helps government and industry meet their mutual objectives and responsibilities;
- analyzing and recommending solutions to the system technical issues that aviation faces as it continues to pursue increased safety, system capacity and efficiency;
- developing consensus on the application of pertinent technology to fulfill user and provider requirements, including development of minimum operational performance standards for electronic systems and equipment that support aviation; and
- assisting in developing the appropriate technical material upon which positions for the International Civil Aviation Organization and the International Telecommunication Union and other appropriate international organizations can be based.

The organization's recommendations are often used as the basis for government and private sector decisions as well as the foundation for many Federal Aviation Administration Technical Standard Orders.

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EXECUTIVE SUMMARY

Operations at large aerodromes have become a complex combination of many activities being performed by many individuals. This group of individuals includes pilots, air traffic controllers, apron controllers, surface vehicle operators, construction/maintenance crews, emergency/security personnel, commercial and cargo airline operations personnel, and general and business aviation operations personnel. All of these individuals must work collaboratively to ensure safe efficient flight operations at the aerodrome. Furthermore, all of these individuals, or *users*, require some knowledge of the aerodrome layout.

Traditionally, pilots navigate on the surface based on visual aids such as airfield markings, signs, and lighting, in conjunction with a paper chart of the aerodrome layout. Radio communication between air traffic control (ATC) and pilots is used to obtain the route to follow while on the surface. ATC will issue route instructions using explicit phraseology along with unique names of legs along the route. ATC must remember the routes given to all aircraft, as well as all aircraft locations, so that no one is directed into a potential collision. If there is a potential for collision, hold-short instructions can be issued over the radio frequency to constrain aircraft movements. To maintain safe separation, surveillance on the aerodrome surface is performed by the flight crews based primarily on the “see-and-avoid” principle. Similarly, ATC performs the surveillance task based primarily on visual cues. Occasionally, both pilots and controllers will use radio communications to confirm positions of relevant traffic. From this brief description of aircraft movements, it is apparent that both ATC and pilots require geospatial information about the aerodrome layout (e.g., the relative location and orientation of runways, taxiways, and stands).

In order to support flight operations at aerodromes, several other activities are required, each performed by separate organizations and/or facilities. The aerodrome authority is responsible for construction and maintenance of aerodrome resources such as buildings, pavement, markings, and landing systems (e.g., ILS). They are also responsible for providing emergency response teams such as fire/rescue and aerodrome security in some cases. Commercial and cargo airline operators perform activities such as apron control, aircraft maintenance and fueling, baggage and cargo handling, catering services, crew and aircraft scheduling, flight planning, and ticketing. They also manage training activities such as flight simulations to assure pilot currency. Finally, General Aviation (GA) and Business Aviation operations are typically supported by Fixed Base Operators (FBOs). FBOs support GA and business aviation operations by providing maintenance, fueling, flight planning, and local ground transportation services. As with pilots and controllers, all of these users also require geospatial information.

The information contained in this document has been compiled by industry for the purpose of stating surface mapping information requirements for users such as those described above. The requirements presented are not all inclusive, but represent those of more immediate concern. Airworthiness authorities, civil aviation authorities, and the aviation industry urge aerodrome mapping database (AMDB) originators and integrators to use this document when providing those data to system designers and users. In addition, this document provides guidance material on structure for exchange of AMDBs. Based on the availability of standardized current AMDBs, a variety of applications can be envisioned. Several are described in this document. This document has been written under the assumption that if all users are using the same AMDB, operations can be improved, and new capabilities can be realized.

The document is organized as follows:

- Section 1 provides background information with respect to the purpose for developing AMDB requirements
- Section 2 describes aerodrome mapping data considerations that are important when attempting to comply with this document
- Section 3 provides general requirements and recommendations for AMDB development
- Section 4 provides more detailed content requirements and specific numerical requirements
- Appendix A provides an overview of the types of applications that may make use of AMDBs

- Appendix B is a glossary of relevant terms
- Appendix C lists important abbreviations and acronyms
- Appendix D may be used as guidance material when creating AMDBs to meet the error assessment requirements specified in this document
- Appendix E is an example of an AMDB exchange structure
- Appendix F lists the membership of the committee that developed this document

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1 PURPOSE AND SCOPE

1.1 Introduction

The information contained in this document has been compiled for the purpose of stating aerodrome surface mapping information requirements for aeronautical uses, particularly on-board aircraft. The term aerodrome is used in this document to include: Aerodromes, Heliports, Vertiports, and Sea-Plane aerodromes. The requirements presented are not all inclusive, but represent those of more immediate concern. As future applications are developed, more stringent numerical requirements may be needed. Airworthiness authorities, civil aviation authorities, and the aviation industry urge the aerodrome mapping data originators and integrators to use this information when providing those data to system designers and users.

Based on the availability of standardized aerodrome mapping databases (AMDBs), a wide variety of applications can be envisioned (Appendix A). It is important to note that multiple user classes can benefit from using these databases including for example: pilots, controllers, aerodrome managers, and aerodrome emergency/security personnel. Each of the applications of AMDBs, as listed below, are described in detail in Appendix A:

- Chart information
- Surveillance and runway incursion detection and alerting
- Route and hold-short display and deviation detection and alerting
- Display of digital ATIS information
- Aerodrome surface guidance and navigation
- Runway operations
- Aerodrome and airline resource management
- Training (flight simulation)
- Aerodrome facility and asset management
- Emergency and security service management
- Notice to airmen and aeronautical data overlays
- Synthetic vision

1.2 Scope

This document provides minimum requirements and reference material applicable to the content, origination, publication, updating, exchange, and enhancement of aerodrome mapping information. The document will also provide guidance to assess compliance and determination of the levels of confidence that need to be reached to support the types of applications listed in Appendix A. This document should be used to support the development and application of AMDBs. AMDBs represent a collection of aerodrome information that is organized and arranged for ease of electronic storage and retrieval in systems that support aerodrome surface movements, training, charting, and planning. This document does not address display aspects of information contained in the databases.

Appendix A is intended to provide an overview of the types of applications that may make use of AMDBs. These application categories have been used to generate the requirements stated herein.

1.2.1 Definition of Terms

The precise meaning of terms is essential for a clear understanding of spoken or written information. This understanding is critical in areas where safety is of concern. Certain terms and expressions used in this document have specific meanings that must not be misconstrued or applied incorrectly. These terms are defined in a glossary in Appendix B. Acronyms are described in Appendix C.

In addition, the following conventions of requirements documents have been adopted:

- The term "should" implies that compliance is not required, but is strongly recommended
- The term "shall" means that compliance is required

1.2.2 Reference Documents

1. RTCA DO-200A/EUROCAE ED-76, *Standards for Processing Aeronautical Data*
2. RTCA DO-201A/EUROCAE ED-77, *Industry Standards for Aeronautical Information*
3. RTCA DO-tbd/EUROCAE ED-98, *User Requirements for Terrain and Obstacle Databases*
4. ICAO Annex 4, *International Standards and Recommended Practices – Aeronautical Charts*
5. ICAO Annex 14, *International Standards and Recommended Practices – Aerodromes and Heliports*
6. ICAO Annex 15, *International Standards and Recommended Practices – Aeronautical Information*
7. ICAO Doc. 9157, *Aerodrome Design Manual*
8. ICAO Doc. 9674-AN/946, *World Geodetic System 1984 (WGS-84) Manual*

1.3 Application of Standards

As stated in RTCA DO-200A/EUROCAE ED-76, "the ultimate responsibility of ensuring that data meets the quality for its intended application rests with the end-user of that data."

Figure 1-1 depicts the data integration processes that contribute to the development of an AMDB. Initially, data originators may collect aerodrome mapping data potentially using many various technologies (e.g., aerial photography, satellite imagery, or topographical surveys). The originators may collect data to support non-aeronautical applications; however, any data to be used to support aeronautical applications must meet the requirements defined herein (illustrated as Requirements A in Figure 1-1). These requirements (see Sections 3 and 4) are not expected to affect existing standards being used for data acquisition. However, in some cases, because of stringent accuracy and integrity requirements, validation procedures may require modification.

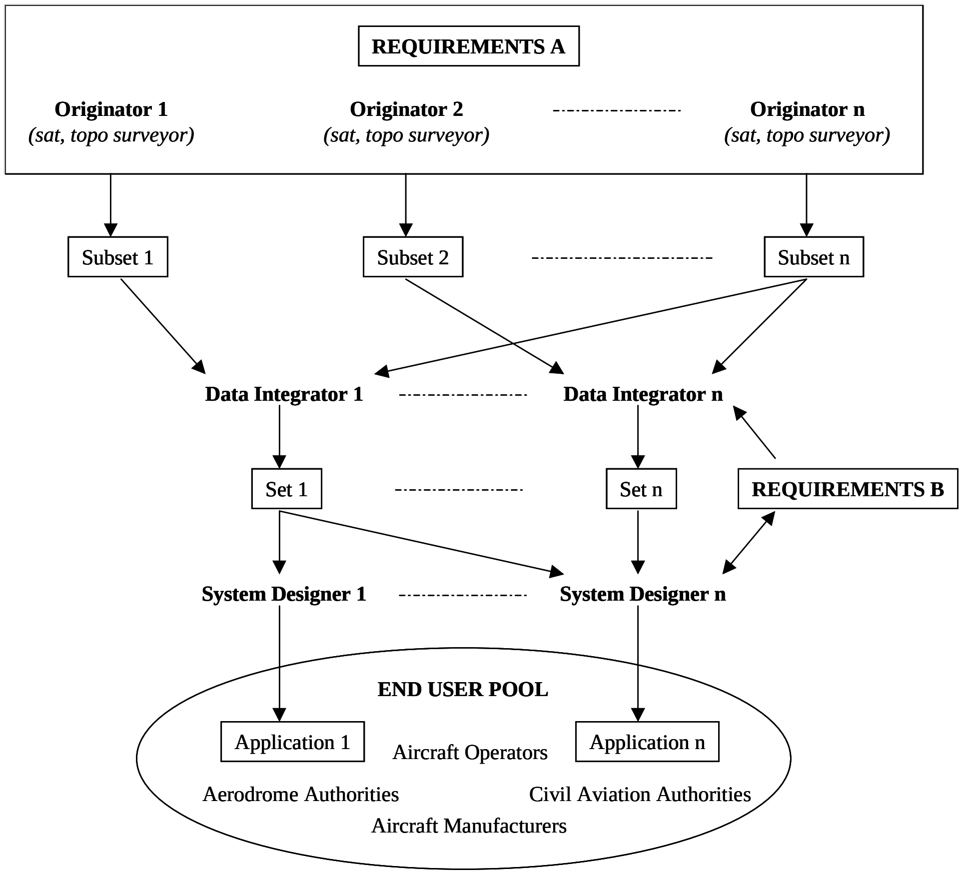


Figure 1-1 Data Integration Processes

Using data provided potentially from multiple data originators, data integrator(s) may be responsible for merging all appropriate data sets for two purposes:

1. the correlation of multiple data sets representing the same aerodrome area to ensure full aerodrome coverage and to ensure the required accuracy and integrity
2. the concatenation of the many aerodromes into a consistent, globally-referenced database that may also include other data types such as terrain, obstacles, and/or air navigation data

Finally, system designers (e.g., avionics manufacturers) may merge specific data sets provided by potentially multiple data integrators to meet the requirements of a specific application. Some of these requirements (illustrated as Requirements B in Figure 1-1) are also defined herein.

The aim of this document is to define a set of requirements to be applied along this chain in order to obtain a database commensurate with the criticality of the final application of the data.

1.4 Aerodrome Mapping Information

1.4.1 Introduction

The advent of ground-based applications based on the use of aerodrome surface data and onboard applications of aerodrome data to support safe, efficient surface movements, has necessitated the development of requirements and reference material applicable to such data.

Most of the existing standards and guidance material are primarily applicable to air navigation data and as such, were not written with aerodrome surface applications in mind. Issues specific to AMDBs include:

- Data may be derived from aerial survey and/or engineering drawings that are not traditional sources of information
- Suppliers of aerodrome mapping data may not be familiar with typical civil aeronautical requirements, standards and methods
- There are many different formats available for aerodrome mapping data (vector, raster, digital elevation models, etc.)
- Aerodrome operators seldom publish changes to their aerodrome data within the ICAO-published AIRAC cycles

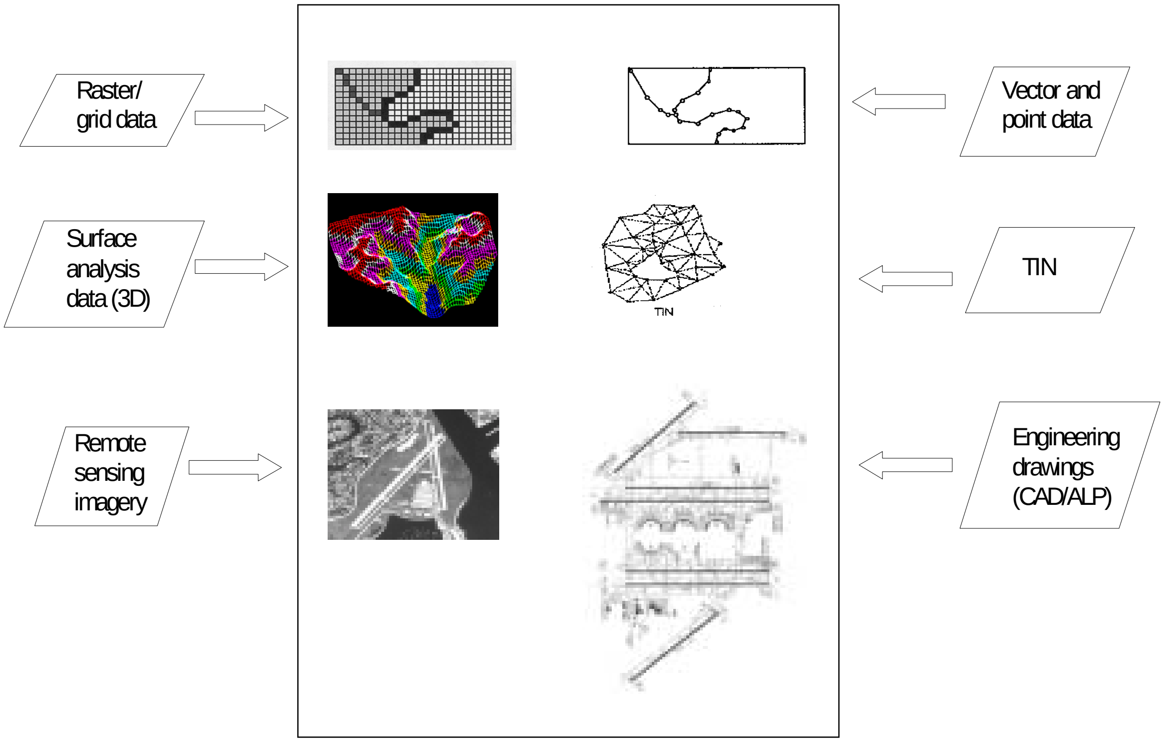
This document is intended to cover these specific issues such that it can be submitted (together with DO-200A/ED-76) to the aviation community as a collection of disciplines necessary to provide assurance that the production of AMDBs meets the high quality required for safe aerodrome surface operations.

The starting point for aerodrome information is the data published by States in their Aeronautical Information Publication (AIP) in accordance with ICAO Standards and Recommended Practices (SARPS) (ICAO Annex 15). However, much of the level of detail required to support the kinds of applications envisaged in Appendix A is not reported on, as it was not necessary for traditional aviation operations. Therefore, other sources of information for the aerodrome may be necessary for these applications.

1.4.2 Overview of Trade Practices

The majority of existing AMDBs have been captured and maintained using Geographic Information Systems (GIS). GIS technology has evolved from the Computer-Aided Design (CAD) industry, combining the detailed information that was available in engineering drawings with a geographic reference system. A GIS is a computer program that combines geographically referenced digital data with spatial and attribute analysis tools. The strength of a GIS lies in the methods it provides to represent and analyze geographic information. A GIS can include many different types of data including: control networks, vector data, raster grid data, triangulated irregular networks (TINs), 3-D surface representations, remotely sensed data, and other digital source data such as geo-referenced drawings or Airport Layout Plans (ALPs) (see Figure 1-2). Within a GIS, these spatial data sources can be combined and analyzed, enabling the user to organize information and answer questions about the spatial relationships between the various thematic layers as well as the attribute characteristics of the features.

In addition to the use of GIS technology, AMDBs have also been realized by digitizing paper charts such as airport obstruction charts, utilizing Computer-Aided Design (CAD) tools, and in text or tabular files.



<u>Figure 1-2</u> AMDB Data Storage Methods

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2 AERODROME MAPPING DATA CONSIDERATIONS

2.1 Reference System Considerations

Converting AMDB data elements to a common datum is an issue when data is referenced to different datums and sufficient conversion algorithms do not exist. Due to air navigation considerations and the state of the art regarding the use of the Global Navigation Satellite System (GNSS) for instantaneous positioning and navigation, it is required that the reference frame for AMDBs be based on the theoretical surface and universally-positioned ellipsoid defined as WGS-84 (see Section 3).

WGS-84 is the required aviation standard for horizontal positioning, but mean sea level (MSL) is used predominately for vertical referencing. MSL elevations can be derived using WGS-84 ellipsoidal heights and an appropriate geoid model. To help ensure global harmonization and until a standard has been adopted by ICAO, the use of the Earth Gravitational Model (EGM-96) is recommended. In the U. S., the Local Area Augmentation System (LAAS) will use the WGS-84 datum and MSL to provide high accuracy navigation data (in conjunction with GNSS) to support tactical precision approach operations. Since the GNSS system will be a major source of navigation and reference data, systems should be designed to accommodate GNSS data wherever possible.

There are several specific advantages to using the WGS-84 reference ellipsoid:

1. The use of a unique universally-located reference frame
2. Consistent with state-of-the-art regarding avionics systems (e.g., GNSS)
3. Simple transformation formulas from ellipsoid to the a cartographic system
4. Problems related to feature positioning, estimation of angles, distances, areas, etc., due deflection of the vertical are minimal and in certain cases negligible
5. Conversion of international aerodromes to WGS-84 has been mandated by ICAO

From an interoperability standpoint, having the data distributed using a common datum is essential. Problems may be encountered when dealing with sources that have an unknown datum.

Further, on-board sensors and avionics instruments may provide dynamic inputs to aerodrome and terrain databases. These are other sources of information that may need to be converted within the system. However, it is expected that these datums will be known and the appropriate conversion can be applied.

In cases where an AMDB already exists and is based on a different reference system, the data must be transformed to a WGS-84 reference. This transformation may induce errors. Therefore, care must be taken to ensure that the conversion process does not impact the integrity of the data and prevent its use in the application for which it was intended.

2.2 Aerodrome Data

2.2.1 Characterization of Aerodrome Mapping Data

Unlike terrain databases, which are typically represented as grid points with associated elevation data, aerodrome databases are typically constructed from a photogrammetric image that is then converted to vectors and assigned themes and attributes using GIS techniques. This is because of the fact that many important data elements are features and not just elevations. These features are more easily characterized by points, lines, and polygons (described in Section 4). Examples include runway edges, hold points, and stand locations. In other words, in AMDBs, not only should the aerodrome surface be properly represented (as is done in terrain databases), but also all existing natural or man-made features should be properly characterized.

The use of vector-based data has several advantages:

1. Small data storage requirement
2. Easy use of a relational data base structure
3. Easier for updating purposes
4. No need of feature recognition software
5. Easy attachment of attributes

Consequently, it is recommended that vector-based data (points, lines, and polygons) be used for the characterization of aerodrome features in AMDBs. An alternate approach is to use raster data or imagery. Using this approach, features are portrayed via contiguous pixels of equal or similar density number. This less precise approach may be acceptable for some applications.

Aerodrome surface data, unlike terrain data, represents regular geometric objects that can be grouped or classified. Examples of classifications are: runways, taxiways, service roads, localizer antennas, glideslope antennas, buildings, radar sites, radio navigation beacon sites, etc. All of these can be described with their own set of attributes, most of which are related to horizontal positioning, and not elevation. These attributes combine to provide a set of aerodrome data requirements that are distinguished from those of terrain data. This distinction must be recognized and preserved, since more attributes will be required to appropriately create the aerodrome images for use by the flight crews.

The array of attributes used to describe aerodrome features is not complete. It will be imperative, to reduce the cost of systems that use the aerodrome data, to use standard representation classes and attributes. It is the intent of this document to define these standards (see Section 4).

2.2.2 Obstacle and Obstruction Data on the Aerodrome Surface

Obstructions are obstacles that penetrate a defined surface. In determining obstruction data requirements, certain accuracy parameters may be applied to construct buffers around obstacles and estimate whether they penetrate the defined surface. However, depending on the radius specified, unrealistically large, converging, or overlapping buffers may be generated resulting in high false alarm conditions. Internationally recognized survey standards should be used. ICAO Annex 14 defines the requirements for identifying obstacle limitation surfaces. This is similar to the OIS schema. Further criteria for evaluating obstacles are contained in Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS). An equivalent approach to those mentioned above has been taken when considering which aerodrome obstacles should be included in AMDBs and declared to be obstructions (see Section 3). Finally, the reader may consider the ongoing RTCA/EUROCAE activity to draft terminal area obstacle requirements.

2.2.3 Terminal Area Terrain Data

Terrain on and around the aerodrome is essential to terminal area airspace operations such as approach, departure, and contingency procedure planning. Hazards related to terminal-area terrain awareness and avoidance have been cited as a major contributing factor in CFIT (controlled flight into terrain) accidents[1]. Terrain is also important to surface navigation. It defines the surface topography of the ground in and around the surface movement areas. Since terrain data shares a physical boundary with many surface geometric objects on the aerodrome, (runways, taxiways, buildings, etc.), it is important that the terrain data be correlated with these other data types. For further information on terrain data requirements, see “User Requirements for Terrain and Obstacle Data.”

[1] Flight Safety Foundation, CFIT Report, 1998

2.3 Application Considerations

2.3.1 Correctness

In most cases, required data accuracy and quality will depend on the intended use of the data and the system in which the data resides. One approach to illustrating this concept is to consider multiple levels of data integrity that correspond to its application's criticality (or impact on safety). For example, consider the following five levels of loss of system integrity due to data errors[2]:

1. Data errors could cause or contribute to the failure of a system function resulting in a *catastrophic* failure condition. A catastrophic failure condition means that substantial loss of human life is possible
2. Data errors could cause or contribute to failure of a system function resulting in a *severe-major/hazardous* failure condition. A severe-major failure condition means that: (a) there is a large reduction in safety margins or functional capabilities, or (b) physical distress or higher workload such that the flight crew could not be relied upon to perform their tasks reliably or completely, or (c) adverse affects on people including serious or potentially fatal injuries to a small number of people. An example might be any system that uses an AMDB to provide the ability for an aircraft to take-off from the runway in low visibility conditions such that the system is relied upon to stay within the confines of the runway prior to liftoff. This is an example only; the actual hazard level of such a system would be determined by a *Functional Hazard Analysis*
3. Data errors could cause or contribute to failure of a system function resulting in a *major* failure condition. A major failure condition means that: (a) there is a significant reduction in safety margins or functional capabilities, or (b) a significant increase in operator workload or reduction in operator efficiency, or (c) discomfort to people involved, possibly including injuries. An example might be any system that provides the ability for an aircraft to taxi on the aerodrome surface in low visibility conditions such that the system is relied upon to avoid low speed collision with obstacles or other hazards. Such a system might also be employed by ground vehicles in low visibility. Adherence to a speed limit might be necessary to prevent such a system from producing severe-major hazards. This is an example only; the actual hazard level of such a system would be determined by a *Functional Hazard Analysis*
4. Data errors could cause or contribute to failure of a system function resulting in a *minor* failure condition. This condition means that: (a) there is a slight reduction in safety margins or functional capabilities, or (b) a slight increase in operator workload or reduction in operator efficiency, or (c) inconvenience to other people involved, possibly including injuries. An example might be a system that provides surface traffic awareness while also supplementing navigation, but is not relied upon for collision avoidance or hazard detection. Another would be a digitized aerodrome diagram that can be used in the same manner as paper charts. This is an example only; the actual hazard level of such a system would be determined by a *Functional Hazard Analysis*
5. Data errors have *no effect* on the safety of persons on the aerodrome. An example might be a map providing the location of storm drains or security gates used for planning purposes.

[2] ICAO Annex 15, *International Standards and Recommended Practices – Aeronautical Information*

2.3.2 Completeness

It is important to note that not all applications will require a “complete” set of aerodrome data to enable intended use. That is, all data types may not be necessary for certain applications. For example, electronic charts that replicate paper charts and are used strictly for flight planning may not require centerline data. Requirements specified in this document need only be complied with for those data types that are needed for a given application. Of course, a complete set of aerodrome data would ensure that all of the envisioned applications could be implemented by system designers.

2.4 Types of Errors

Errors in AMDBs can be classified into three types: *Random Errors, Blunders, and Systematic Errors*. These are defined in Appendix D. With respect to data acquisition for AMDBs, statistical methods should be applied in order to assess the random errors. Digital filters, based on statistical principles should be designed in order to locate and eliminate blunders. There are, in surveying sciences, highly efficient techniques for this purpose.

With respect to systematic errors, deterministic procedures should be adopted to correct the observations or taken into consideration in the derived statistics. Each data acquisition method or data to be acquired has its own systematic effect or bias included in the value of the statistics itself. To eliminate it there are two recommended approaches:

1. The use of an appropriate mathematical model that describes the systematic effect (e.g., earth curvature, refraction, etc.)
2. The use of extended models to account for a combination of systematic effects of known sources and quasi-random effects that are difficult to model. A typical example is the auto-calibration used in photogrammetric aero-triangulation.

Geospatial databases are three-dimensional, expressing features in two spaces: horizontal and vertical. Two dimensions, latitude and longitude, are used to express the horizontal space location, while the elevation is used to express the vertical space location. When considering mapping data, the general error types described above, take three basic forms of errors in the final product. The three forms of errors in these databases are: (a) incorrect horizontal location for an elevation value, (b) incorrect elevation for a horizontal location, or (c) both. These types of errors are the most important consideration when using the data. The three types of errors may be indistinguishable when the data is used, however there are certain traits of these errors:

- Groups of data may share a common error, such as a translation error in which a geographic region or feature is displaced. In AMDBs, latitude/longitude errors are generally of more interest than elevation errors because data changes predominantly in the horizontal space (i.e., aerodromes are relatively flat). These location errors are generally a fundamental attribute of the database, and are created by the measurement techniques used when the data is taken (i.e., a Systematic Error). DO-201A/ED-77 describes the convention that is required by the aviation industry to minimize the effects of this type of systematic error. In general, it states that measurements and calculations should be carried to at least one more decimal place than will be required in the final value.
- Elevation error may vary in an indistinguishable manner (i.e., a *Random Error*). This is another basic attribute of databases, and again is a function of the measurement equipment.
- Individual errors (i.e., *Blunders*) may exist in the database as evidenced by “spikes” in the data. These individual anomalies are, in general, easier to recognize than the systematic errors discussed above. Software in the user system may perform simple anal-

yses to determine if the rate of change of data is higher than expected, thus sifting out these anomalous data points.

2.4.1 Effect of Errors on System Integrity

System integrity is related to AMDB errors in that integrity can be compromised if errors in the database exist and cannot be detected by the operational system. In a typical avionics system, techniques to boost system integrity are as follows:

- A thorough analysis, called a *Functional Hazard Assessment (FHA),* is performed on the system to determine the failure modes that contribute to undesired top-level events. The integrity of the system cannot be understood until this analysis is completed. Using the output of the FHA, the system can be designed to eliminate or mitigate the effects of the failures contributing to the top-level events. Using architectural techniques such as system redundancy, perhaps even using dissimilar implementations, can increase system integrity. In general, redundancy allows comparison of system outputs and allows detection of system failure. Use of dissimilar implementations ensures that one implementation does not have a systemic flaw/error that could adversely affect integrity.
- The addition of monitoring and built-in-test equipment (BITE) functions allows detection of system failures. The effect of monitoring/BITE is to lower the probability of undetected failure/error, which in turn will increase system integrity.

The techniques listed above are not intended to be comprehensive. The intent is to highlight that AMDBs may contain undetectable errors, and these types of errors must be considered in the design of the system that uses an AMDB and the allowed operational uses of the system.

2.4.2 Errors that Affect the Confidence Level of a Database

Point estimation is the estimation of the mean, variance, and covariance of a random variable from sample data. Questions that arise are — how good is the estimation and how much can it be relied on? A simple answer is not possible because sampling never leads to the true, theoretical distribution or its parameters. It is only possible to estimate a probability that the true value of the parameter in question is within a certain interval around the estimate. This probability is called the *Confidence Level*, conventionally required to be 90%, 95%, or 99%, depending on how the data is to be used. Further, the confidence level of an AMDB is directly related to the lowest confidence level for any existing random variable in the database. Any type of error may affect the confidence level of the data base, but systematic and blunder errors will have a larger impact. Therefore, to achieve high confidence levels, it becomes critical to locate and eliminate these systematic and blunder-type errors if at all possible before the data becomes available to the end users.

2.4.3 Accuracy and Precision

For the purposes of this document, accuracy is defined as the degree of conformance between the estimated or measured value and the true value. Precision is defined as the smallest difference that can be reliably distinguished by a measurement process. The main difference between precision and accuracy lies in the possible presence of bias or “systematic error”. Although precision includes only random effects, accuracy comprises both random and systematic effects. Both terms are used often with the same meaning. This is because in surveying practice, in the majority of cases, the true value is not known and only a most probable value is estimated via random sample measurement procedures. All observed (random variables) or derived statistics should be qualified through their corresponding accuracy parameters such as mean, variance, standard deviation, and covariance.

2.4.4 Resolution

There are many definitions for the term resolution. The ICAO definition given in Appendix B is used in Section 4.1.2 with respect to AMDB resolution requirements. This definition states that resolution is the number of units or digits to which a measured or calculated value is expressed and used. However, other more specific definitions are used in surveying science and particularly in the field of image processing. Examples include: spatial resolution, spectral resolution, radiometric resolution, and temporal resolution. These are defined in Appendix B and further described in Appendix D. It is important to note that for AMDBs, not all aerodrome features need to be measured or specified to the same resolution.

2.4.5 Timeliness Effects and Currency Errors

One of the most important attributes of a database is its currency. This informs the user of the date of its latest update or the effective date of the data. This information should be available at any time to the user. Aerodromes are frequently undergoing construction activities. However, due to the present infeasibility of continuous updating of AMDBs, changes that occur between the standard update cycle will not be considered to be available as part of the AMDB until the subsequent update. In the interim, this data may be provided to users via a Notice to Airmen (NOTAM) or other means if appropriate.

For some applications, aerodrome, terrain, and obstacle databases must be integrated. This integration of data is typically accomplished by layering of the various information sources into an information hierarchy that supports the application and associated display processing. The data that contributes to these layers is subject to varying levels of change, which in turn suggests that the data will be updated at different times, or in cycles of differing length. This inconsistency may result in unexpected database errors that can be difficult to detect by the system designer or the end user. For this reason, database suppliers and integrators are required to provide documentation on their timeliness and update process (see Section 3.7).

2.4.6 Semantic Errors

These are generally considered blunder errors. Examples include errors due to the misidentification of an object (e.g., a tower for a mast, a tree for a pole, a road for a railroad); errors due to misclassification of a theme (e.g., sand for clay); and errors due to incorrect attachment of attributes (e.g., length for width). These blunder errors will affect the consistency and the reliability of the AMDB. Consistency checks are recommended to be performed once the initial database is produced and again on each update.

3 GENERAL REQUIREMENTS

In addition to the following requirements, those described in DO-200A/ED-76 are applicable.

3.1 Position Data

3.1.1 The horizontal reference for all position data shall be the WGS-84 ellipsoid.

3.1.2 All aerodrome mapping data that includes horizontal position information shall be described in units of latitude/longitude for the purpose of data exchange.

3.1.3 It is expected that for many applications, implementation may include conversion to a local coordinate system (e.g., Cartesian) along with at least one geodetic reference point. Data quality shall be preserved when performing coordinate system conversion.

3.1.4 For all aerodrome mapping data that requires a vertical component, the vertical reference shall be orthometric height for the purpose of data exchange. The orthometric height of a point is related to the geoid and is generally presented as an MSL elevation. Orthometric height can be derived using WGS-84 ellipsoidal heights and an appropriate geoid undulation. It is recommended that the geoid undulation is derived by using the Earth Gravitational Model 1996 (EGM-96). If EGM-96 is not used, the geoid used to derive the orthometric height in the survey shall be provided.

3.1.5 The metric system shall be used for all distance and dimensional measurements.

3.2 Data Acquisition

Any method is acceptable for capturing aerodrome-mapping data subject to the information requirements specified in this document. Examples include: aerial photogrammetry, satellite photogrammetry, field surveying, and digitizing existing charts.

3.2.1 A description of the process used to acquire aerodrome mapping data shall be provided. This shall be consistent with DO-200A/ED-76.

3.3 Data Merging

3.3.1 In order to ensure quality where multiple data sets are merged to create a complete AMDB, each individual data set shall be geo-referenced to the WGS-84 ellipsoid.

To avoid potential mismatch problems resulting from different features or themes being captured by different methods and/or originated from different sources, it is recommended that digital graphical editing procedures be used to align and/or match the shifted features using as reference the feature(s) that was geo-referenced with the highest accuracy.

3.4 Data Conversion

3.4.1 Data sets may be converted to WGS-84 latitude/longitude; however, the original data, prior to conversion, shall meet the quality standards described in this document.

3.4.2 Algorithms used to convert data to WGS-84 shall not degrade the data quality below those described in this document.

3.5 Data Source Identification

3.5.1 The data originator shall identify the source of any aerodrome mapping data provided to the user.

3.6 Data Traceability

Traceability is the ability to track the history, application or location of an entity by means of recorded identifications. More specifically, it is the degree to which a system or data product can provide a record of the changes made to that product and thereby enable an audit trail to be followed from the end user to the data originator.

3.6.1 The source data originator shall produce adequate information such that the traceability of an AMDB can be maintained according to the above definition and in accordance with DO-200A/ED-76. Traditionally, a survey report generated by an accredited surveyor will contain sufficient information. If this type of survey report is generated, the data originators shall release this report on request.

3.6.2 The data handler, manipulator, integrator, and/or provider shall produce adequate information such that the traceability of an AMDB can be maintained according to the above definition and in accordance with DO-200A/ED-76. Typically, this can be accomplished with the provision of an appropriate Meta-data record or attribute for each contextual data subset as described in Section 4.

3.7 Database Update Cycles and Timeliness

3.7.1 Timeliness refers to updating AMDBs to account for errors that have been uncovered as well as to change appropriate data (e.g., due to construction activities). According to DO-200A/ED-76, aerodrome data shall be updated in accordance with the AIRAC cycle amendment schedule. Changes that occur within this period may be provided by NOTAM, data link, or an equivalent method. The method of informing the user of changes will depend on the operational use of the data.

3.7.2 Given that the data has been correctly published or otherwise made available by the data originator, the data integrator shall issue the updated database at the next AIRAC date. In addition, the integrator shall provide a list of changes that have occurred since the previous issuance.

3.7.3 Database updates shall be provided, at a minimum, for a complete, contextual AMDB sub-class (see Section 4). For example, if changes to runway markings are performed on the database, it is then the responsibility of the data handler to provide to its data consumers, at a minimum, the complete runway marking database contextual sub-class. The database handler or integrator has the option of providing a complete, updated AMDB or just the sub-class.

3.8 Processing, Handling, and Distribution of Aeronautical Data

It is essential that the integrity of aeronautical database products, as set forth in this document, be preserved during all phases of transfer, distribution, dissemination, or otherwise handling of the data. This requirement applies equally to individual data elements as to the overall AMDB.

3.8.1 Requirements for handling and processing of aeronautical data are described in DO-200A/ED-76.

In order to ensure specific integrity of all data for the anticipated uses of the AMDB, further specific requirements may be elaborated between users and the data suppliers in order to meet specific operational uses.

3.9 Verification and Validation

3.9.1 Sufficient verification and validation of all data shall be performed such that the quality of the data is assured in accordance with DO-200A/ED-76.

Additional validation may also be necessary for the benefit of suppliers and airworthiness authorities addressing certification of equipment or equipment components relying on the use of AMDBs because:

- AMDBs involve complex technology, that is relatively rapidly evolving
- The number of applications based on such databases will likely increase in the future
- The safety assessment, required by all certification authorities, may depend directly on a statement of the overall integrity of the AMDB
- Some aerodrome surface movement issues are not addressed by current airworthiness documents or guidance materials

3.9.2 In addition to the methods that are described in DO200A/ED-76; adequate documentation of the measurement and mathematical transformation stages shall be available for demonstration that the database has sufficient overall integrity to satisfy the function's requirements for certification. However, if it is not the case, other methods shall be employed to make the demonstration.

The following techniques should be considered:

- Measurement of a sample of the database points with an independent measurement system. For example the use of GPS equipment at specific points to compare to the same points in a database that was created by photogrammetric methods. The overall integrity of the database can be estimated to arbitrary levels of confidence depending on the number of samples that are checked: more samples give better confidence.
- Comparison of the target database to other recorded data. In every case of comparison against other data, the vertical and horizontal references datums for the two data sets should also be compared.
- The validity is demonstrated by actual use of the database. This can be accomplished by using the equipment in simulation runs to demonstrate its viability of operation. The use of simulation needs to be demonstrated against standards of procedure. Operational testing of the equipment can be used to demonstrate the validity of the target database. The supplier needs to have clearly derived the location of the flight testing to maximize the testing of the use of the target database in areas for which invalidity could cause problems.
- The database can be validated or have its validation improved by being generally installed in aircraft for non-operational or partial operational use. This approach needs to be thoroughly set up such that the validity of its logic is thoroughly examined.

The combination of the validation techniques used needs to produce evidence that an appropriate subset of the data has been validated. Namely the subset of the database upon which the validation is performed is a representative sample of the aerodrome area covered by the database. The certification authority should be satisfied that the sampling technique approach used is appropriate.

3.10 Supplier Qualifications

3.10.1 Suppliers shall provide aerodrome mapping data with sufficient quality information in order for the end user to verify and validate that the data is suitable for its intended use.

Certification/accreditation of suppliers should be considered to demonstrate compliance with existing ICAO SARPS, guidance material, and relevant ISO quality management standards.

3.11 Data Element Extent and Boundary Definition

A complete AMDB is composed of a variety of thematic data elements; for example, vertical objects, runways, taxiways, and building geometry. The methods employed to collect and handle each data type may differ widely. For example, vertical object data may be obtained using traditional ground-based aerodrome surveys. In addition to collection methods, the data types pose different hazards, risks, and informational opportunities to surface and terminal-area navigation applications. Therefore, the spatial or surveyed extent of the AMDB is defined on an element-by-element basis. Practical methods of data collection employed by industry (vis. a vis. aerodrome surveyors and GIS specialists) are also considered when defining the AMDB extent. Note: specific requirements for aerodrome mapping terrain data are described separately in the draft RTCA/EUROCAE document “User Requirements for Terrain and Obstacle Data”.

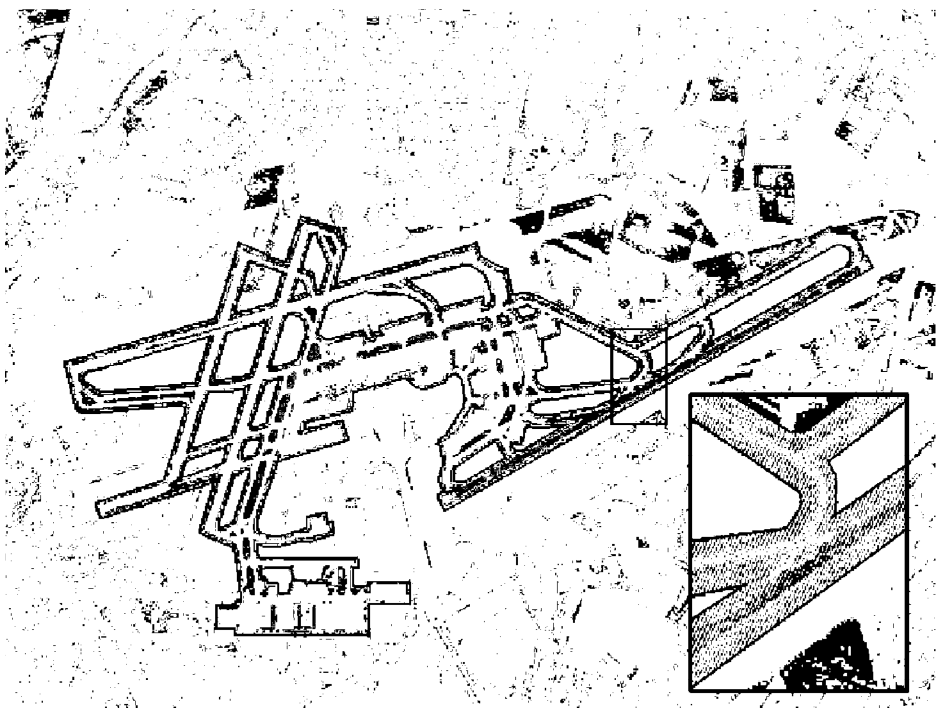

Figure 3-1 Aerodrome Mapping Data Horizontal Extent (Paris-Orly)

3.11.1 Vertical Objects

Vertical objects on the aerodrome surface have traditionally been collected according to ICAO Annex 14, PANS-OPS, or FAR 77 (see Section 2.2.2). However, requirements set forth in this document, as driven by emerging applications, will exceed these previously defined requirements. For example, applications requiring *Fine* quality data (see Section 4) require many elements in the movement area be surveyed to sub-meter accuracy. Initially, these high-accuracy survey requirements will be imposed upon a region in and around the movement areas. Rationale for the vertical extent boundary is driven by three considerations: (1) wing-tip and airframe clearance requirements, (2) air-ground (landing) and ground-air (take-off) proximity operations, and (3) helicopter maneuvering operations.

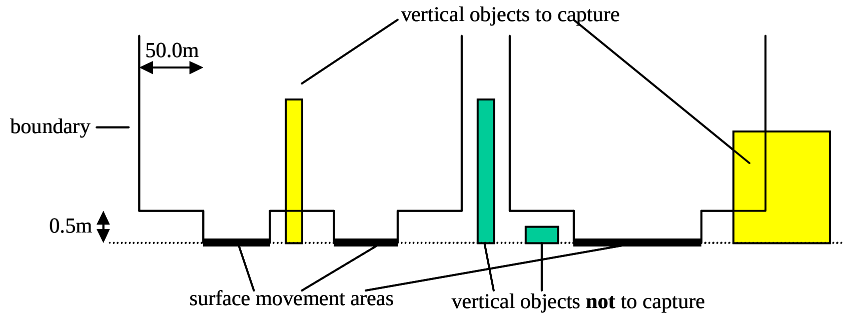

Figure 3-2 Aerodrome Mapping Data Vertical Extent

3.11.1.1 When surveying vertical objects, the horizontal spatial extent to be surveyed shall include the aerodrome surface movement area plus a buffer of 50 meters (Figure 3-1 to Figure 3-2), or the minimum separation distances specified in ICAO Document 9157, whichever is greater.

3.11.1.2 All vertical objects and terrain in the horizontal spatial extent region that extend more than 0.5 meters above the horizontal plane passing through the nearest point on the aerodrome surface movement area may be hazardous for surface movement and shall, therefore, be surveyed (Figure 3-2).

3.11.2 Aerodrome Structures

Aerodrome structures is a general term used to describe the aerodrome terminal, tower, hangars, and other miscellaneous buildings on the aerodrome surface. Based on the geometric complexity of these objects, they are not traditionally surveyed, or in some cases only the corners are surveyed. Future applications, particularly those with regard to efficiency and routing applications, will require detailed models of these geometric elements. Therefore, the following requirement is asserted:

3.11.2.1 Aerodrome structures shall be modeled with a two-dimensional bounding polygon and a maximum height field, indicating the highest point on the building extent (bounding box). Towers and antennas protruding from the top of the building shall be captured as vertical objects.

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4 SPECIFIC REQUIREMENTS

Aerodrome information consists of aerodrome features and associated information in the form of geometry, attributes, and attribute coding. Information should be linked to data either via a relational database schema or an equivalent method. If meta-data information is common to multiple elements, this can be provided only once for the associated group of data elements. See Appendix E for recommended structure, naming conventions, and coding.

4.1 Geometry

For the purposes of this document, geometries are described by points, lines, and polygons.

A point is the smallest unit of geometry and has no spatial extent. Points are described by two-dimensional (2-D) or three-dimensional (3-D) coordinates.

A line consist of a connected sequence of points. Start- and end-points of a line are referred to as *start*- and *end-node*. Connecting points that are in between *start*- and *end-nodes* are referred to as *vertices*. Vertices are intermediate points that define the line structure, curvature, or shape. A start-node and an end-node define a line's directionality.

A polygon is a surface described by a closed line (i.e., a line whose start-node and end-node are coincident). The closed line forms the outer edge of the surface.

4.1.1 Accuracy

Accuracy requirements are specified according to three categories: *Fine*, *Medium*, and *Coarse*. These categories are defined in Section 4.6.

4.1.1.1 Aerodrome mapping data accuracy shall meet a confidence level of 95% for *Fine* and 90% for *Medium* or *Coarse* quality categories. Further, there may be data elements at specific aerodromes that are deemed critical in terms of operational safety by system designers. For these elements, sufficient validation may be necessary to ensure that the stated accuracy is not only at the required confidence level, but also bounded to a prescribed worst-case inaccuracy. Aerodrome mapping geometry data shall meet the accuracy requirements listed in Tables 4-1 through 4-4. The accuracy requirement listed for a particular data element applies to all position coordinates that constitute that data element.

4.1.1.2 As stated in 4.1.1.1, in order to bound the error for certain elements, an additional accuracy value has been defined. The *Max Error* column of Table 4-5 refers to maximum acceptable error. Most of the numbers in Table 4-5 represent approximately a six standard deviation value for a normal distribution. This value shall not be exceeded for the elements specified. Where indicated, this limit shall be applied only to *Fine* category data.

Positional accuracies are relative to a positional datum. It is recommended that accuracies be relative to the WGS-84 reference network at the aerodrome (in the U.S., these are referred to as Primary Aerodrome Control Sites [PACS][1]).

4.1.1.3 For any required data element that requires multiple vertices, the number of vertices shall be sufficient to maintain the required horizontal and vertical accuracy as well as to distinguish any points where multiple elements intersect.

[1] "Standards for Aeronautical Surveys and Related Products", FAA Doc. No. 405, September, 1996.

4.1.2 Resolution

4.1.2.1 Resolution shall be sufficient to guarantee both the horizontal and the vertical accuracy requirements listed in Tables 4-1 through 4-4. These represent the minimum resolution required. The definition in Appendix B for resolution shall be used with respect to Tables 4-1 through 4-4.

4.1.3 Feature Extraction

4.1.3.1 Geospatial locations of the *start-node* and *end-node* of any line that forms a polygon shall be identical (coincident).

4.1.3.2 All polygonal data elements shall be vectorized in counter clockwise order. No polygon shall overlap or intersect another polygon (simple topology).

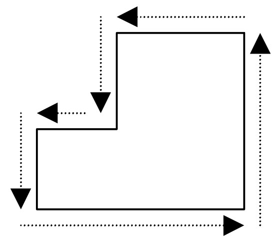

Figure 4-1 Ordering of Polygon Points

4.1.3.3 Polygons that share an edge shall share all vertices along this edge. This shall be applied for features of the same feature class and for features of different feature classes.

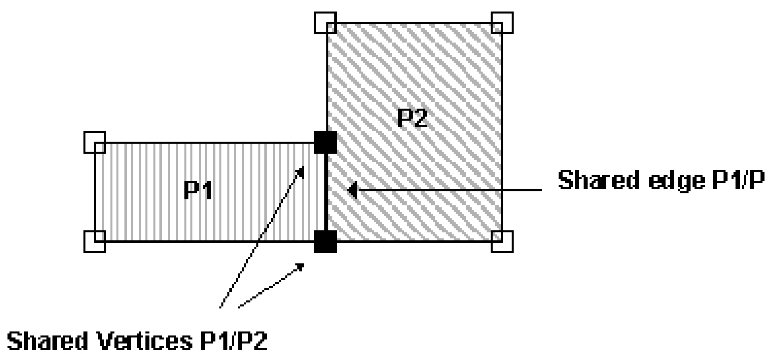

Figure 4-2 Polygons with a Shared Edge

4.1.3.4 Taxi guidance line objects shall start at the location closest to the runway and end at the location closest to the parking position or apron (whichever is appropriate).

4.1.3.5 Lines representing surface markings (e.g., runway centerline) shall be located in the center of the painted marking except where otherwise stated.

4.1.3.6 To ensure connectivity between connecting lines (e.g., taxi-lines), the end-node of the first line and the start-node of the next line shall have identical (coincident) coordinates. This shall be applied for features of the same feature class and for features of different feature classes.

4.2 Attributes

4.2.1 Completeness

4.2.1.1 For each feature, all of the attributes defined in Section 4.3 shall be provided. If a particular attribute is “unknown” or “not applicable” it shall be listed as such.

4.2.2 Attribute Names

4.2.2.1 All attribute names shall be constrained as follows:

- No duplicate names
- Only letters from US-ASCII code (a..z)
- Maximal eight letters
- Only lower case letters

4.2.3 Attribute Values

A specific attribute value representation is not required. Appendix E provides example attribute value assignments.

4.3 Required Aerodrome Data Elements

For the purposes of this document, required data elements have been listed by class. The seven classes are runways, helipads, taxiways, aprons, vertical structures, construction areas, and quality data. Each class requires that different objects be captured in the AMDB. Note that all elements shall have sufficient geometry data (coordinate data) to ensure the required accuracy (see Section 4.1.1).

4.3.1 Runways

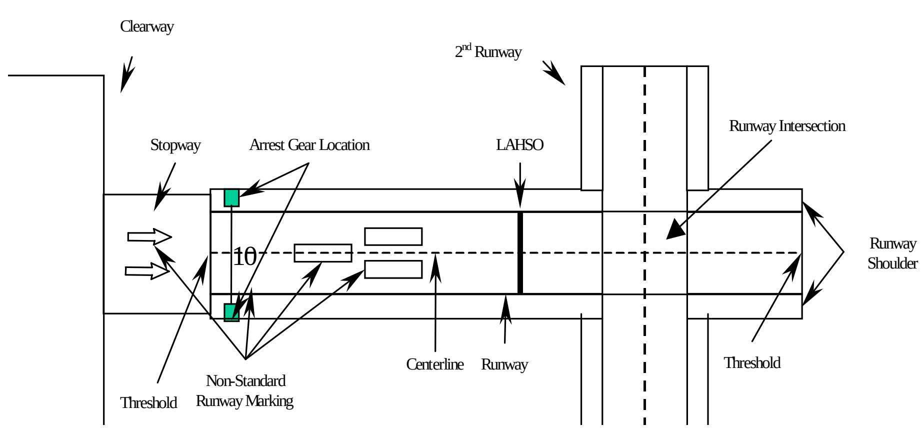

Figure 4-3 Required Runway Elements

4.3.1.1 Runway Polygons

4.3.1.1.1 All runways (see Definition: ICAO Annex 14, Chapter 1) shall be individual objects in the database. This shall not include the runway shoulders and stopways. All runway information that is related to a landing direction shall be attached to the corresponding threshold (e.g., information for RWY 25 will be attached to the threshold point feature for the landing direction 25).

Geometry: Polygon

Attributes:

1. Runway feature type identifier
2. ICAO aerodrome location indicator
3. Object identifier
4. Vertical accuracy
5. Horizontal accuracy
6. Vertical Resolution
7. Horizontal Resolution
8. Name of entity or organization that supplied data
9. Data integrity to support the end-to-end quality system from provider to end user
10. Date of last revision or generation of source data
11. PCN number of runway
12. Width of the runway
13. Length of the runway
14. Surface type of the runway

4.3.1.2 Runway Intersection

4.3.1.2.1 When two or more runways intersect, the intersection shall be kept as an individual object in the database. The runway intersection feature is defined as the area of intersection between two or more runways or a runway and a stopway.

Geometry: Polygon

Attributes:

1. Runway intersection feature type identifier
2. ICAO aerodrome location identifier
3. Object identifier
4. Vertical accuracy
5. Horizontal accuracy
6. Vertical Resolution
7. Horizontal Resolution
8. Name of entity or organization that supplied data (RTCA/DO-200A)
9. Data integrity to support the end-to-end quality system from provider to end user
10. Date of last revision or generation of data source.
11. PCN number of runway intersection
12. Surface type of the runway intersection

4.3.1.3 Threshold Points

4.3.1.3.1 All runway thresholds (see definition: ICAO Annex 14, Chapter 1) shall be individual objects in the database. All runway information that is related to a landing direction shall be attached to the corresponding threshold. The threshold points shall be captured in three dimensions and located according ICAO Doc 9674 (WGS84)-Manual, Chapter 5.

Geometry: Point

Attributes:

1. Threshold feature type identifier
2. ICAO aerodrome location indicator
3. Object identifier
4. State of runway in corresponding takeoff/landing-direction at day of data generation/ revision: Open or closed

5. Vertical accuracy
6. Horizontal accuracy
7. Vertical Resolution
8. Horizontal Resolution
9. Name of entity or organization that supplied data
10. Data integrity to support end-to-end quality system from provider to end user
11. Date of last revision or generation of source data
12. Touchdown zone (ICAO Annex 14, Chapter 1.1) elevation in both the MSL and ellipsoidal height corresponding to threshold location
13. Touchdown zone longitudinal slope (slope of 1/3 of the runway length from threshold or first 3000 feet for runways longer than 9000 feet) corresponding to threshold location
14. True runway bearing corresponding to landing direction (ICAO Annex 14, Chapter 3.1.12)
15. Magnetic runway bearing corresponding to threshold location valid at the day of data generation
16. Runway slope corresponding to landing direction
17. Take-off run available (ICAO Annex 14, Chapter 1.1) corresponding to threshold location
18. Take-off distance available (ICAO Annex 14, Chapter 1.1) corresponding to threshold location
19. Accelerate-stop distance available. (ICAO Annex 14, Chapter 1.1) corresponding to threshold location
20. Landing distance available (ICAO Annex 14, Chapter 1.1) corresponding to threshold location
21. List of available landing and runway lighting system corresponding to threshold location
22. Type and Category of precision approach guidance system available
23. Geoidal Undulation at the threshold point

4.3.1.4 Runway Markings

4.3.1.4.1 The outline of markings painted on runways (see definition: ICAO Annex 14, Chapter 1.1) shall be individual objects in the database. These markings shall include runway designation marking, runway centerline marking, threshold marking, traverse stripes, touchdown zone marking and runway side stripe marking.

Geometry: Polygon

Attributes:

1. Runway marking feature type identifier
2. ICAO aerodrome location indicator
3. Vertical accuracy
4. Horizontal accuracy
5. Vertical Resolution
6. Horizontal Resolution
7. Name of entity or organization that supplied data
8. Data integrity to support the end-to-end quality system from provider to end user
9. Date of last revision or generation of source data

4.3.1.5 Centerlines

4.3.1.5.1 All centerlines shall be individual objects in the database. This is a continuous line along the painted centerline of a runway connecting the two thresholds. The centerline shall provide sufficient data in all three dimensions to calculate touchdown zone slopes and runway slopes.

Geometry: Line

Attributes:

1. Centerline feature type identifier
2. ICAO aerodrome location indicator
3. Vertical accuracy
4. Horizontal accuracy
5. Vertical Resolution
6. Horizontal Resolution
7. Name of entity or organization that supplied data
8. Data integrity to support the end-to-end quality system from provider to end user
9. Date of last revision or generation of source data

4.3.1.6 Land and Hold Short (LAHSO) Locations

4.3.1.6.1 All LAHSO locations shall be individual objects in the database. These are lines representing the outer edge (away from intersecting runway/taxiway) of the LAHSO line as painted on the runway or marked by other means (e.g., lighting).

Geometry: Line

Attributes:

1. LAHSO feature type identifier
2. ICAO aerodrome location indicator
3. Object identifier
4. Vertical accuracy
5. Horizontal accuracy
6. Vertical Resolution
7. Horizontal Resolution
8. Name of entity or organization that supplied data
9. Data integrity to support the end-to-end quality system from provider to end user
10. Date of last revision or generation of source data
11. Identification of corresponding runway or taxiway that is being protected

4.3.1.7 Arresting Gear Locations

4.3.1.7.1 All arresting gear locations shall be individual objects in the database. These are lines connecting the two fixed points of any arresting gear cables on each side of a runway.

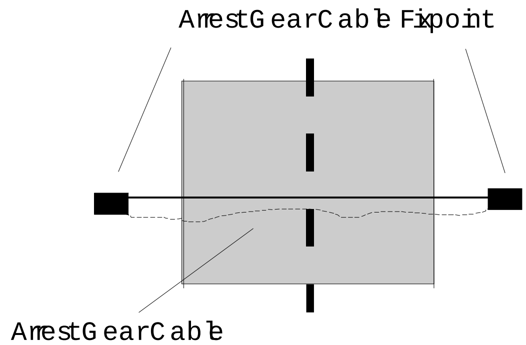

Figure 4-4 Arresting Gear Locations

Geometry: Line

Attributes:

1. Arresting Gear feature type identifier
2. ICAO aerodrome location indicator
3. State of arresting gear at day of data generation/revision: operative or inoperative
4. Vertical accuracy
5. Horizontal accuracy
6. Vertical Resolution
7. Horizontal Resolution
8. Name of entity or organization that supplied data
9. Data integrity to support the end-to-end quality system from provider to end user
10. Date of last revision or generation of source data

4.3.1.8 Runway Shoulders

4.3.1.8.1 All runway shoulders (see definition: ICAO Annex 14, Chapter 1.1) shall be individual objects in the database.

Geometry: Polygon. This can be multiple polygons that together form the complete runway shoulder.

Attributes:

1. Runway shoulder feature type identifier
2. ICAO aerodrome location indicator
3. State of runway shoulder at day of data generation/revision: Usable or Unusable
4. Vertical accuracy
5. Horizontal accuracy
6. Vertical Resolution
7. Horizontal Resolution
8. Name of entity or organization that supplied data
9. Data integrity to support the end-to-end quality system from provider to end user
10. Date of last revision or generation of source data
11. Surface type of the runway shoulder

4.3.1.9 Stopways

4.3.1.9.1 Each stopway (see definition: ICAO Annex 14, Chapter 1.1) of a runway shall be an individual object in the database. A stopway shall be attached to the threshold of the corresponding runway.

Geometry: Polygon

Attributes:

1. Stopway feature type identifier
2. ICAO aerodrome location indicator
3. Object identifier
4. Status of stopway at day of data generation/revision: usable or unusable
5. Vertical accuracy
6. Horizontal accuracy
7. Vertical Resolution
8. Horizontal Resolution
9. Name of entity or organization that supplied data
10. Data integrity to support the end-to-end quality system from provider to end user
11. Date of last revision or generation of source data
12. Surface type of stopway

4.3.1.10 Clearways

4.3.1.10.1 Each clearway (see definition: ICAO Annex 14, Chapter 1.1) of a runway shall be an individual object in the database. A clearway shall be attached to the threshold of the corresponding runway or, if available, to the end of a corresponding stopway as defined by JAA/FAA rules.

Geometry: Polygon

Attributes:

1. Clearway feature type identifier
2. ICAO aerodrome location indicator
3. Object identifier
4. Vertical accuracy
5. Horizontal accuracy
6. Vertical Resolution
7. Horizontal Resolution
8. Name of entity or organization that supplied data
9. Data integrity to support the end-to-end quality system from provider to end user
10. Date of last revision or generation of source data

4.3.2 Helipads

As shown in Figure 4-5, helipad information consists of the final approach and take-off area (FATO), the touchdown/lift-off area (TLOF), and the helipad threshold location (ICAO Doc 9674 WGS84-Manual, Chapter 5 Attachment C).

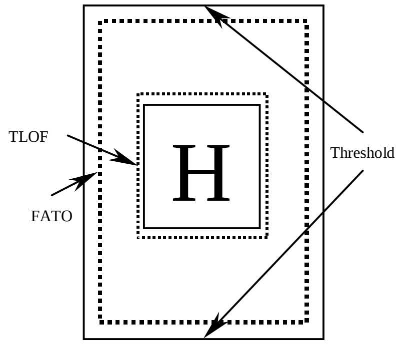

Figure 4-5 Required Helipad Elements

4.3.2.1 FATOs

4.3.2.1.1 Final approach and takeoff areas (FATO) shall be included (ICAO Doc 9674 WGS84-Manual, Chapter 5 Attachment C) as individual objects in the database.

Geometry: Polygon. This can be multiple polygons forming the overall helipad.

Attributes:

1. FATO feature type identifier
2. Aerodrome/Heliport identifier
3. State of FATO at day of data generation/revision: open or closed
4. Vertical accuracy
5. Horizontal accuracy
6. Vertical Resolution
7. Horizontal Resolution
8. Name of entity or organization that supplied data
9. Data integrity to support the end-to-end quality system from provider to end user
10. Date of last revision or generation of source data
11. Surface type of the FATO

4.3.2.2 TLOFs

4.3.2.2.1 Touchdown/lift-off areas (TLOF) shall be included as individual objects in the database. This is the touchdown/liftoff area of the helipad as specified by the marking. TLOF can be missing if FATO exists (ICAO Doc 9674 WGS84-Manual, Chapter 5 Attachment C).

Geometry: Polygon

Attributes:

1. TLOF feature type identifier
2. Aerodrome/Heliport identifier
3. Vertical accuracy
4. Horizontal accuracy
5. Vertical Resolution
6. Horizontal Resolution
7. Name of entity or organization that supplied data
8. Data integrity to support the end-to-end quality system from provider to end user

9. Date of last revision or generation of source data
10. Surface type of the TLOF

4.3.2.3 Thresholds

4.3.2.3.1 Helipad thresholds shall be included as individual objects in the database and located according ICAO Doc 9674 WGS84-Manual, Chapter 5 Attachement C.

Geometry: Point

Attributes:

1. Helipad threshold feature type identifier
2. Aerodrome/Heliport identifier
3. Vertical accuracy
4. Horizontal accuracy
5. Vertical Resolution
6. Horizontal Resolution
7. Name of entity or organization that supplied data
8. Data integrity to support the end-to-end quality system from provider to end user
9. Date of last revision or generation of source data
10. Status of corresponding FATO/TLOF (open/closed)
11. Geoidal elevation of threshold point

4.3.3 Taxiways

As shown in Figure 4-6, taxiways include runway exit taxiways and apron taxiways (see definition: ICAO Annex 14, Chapter 1.1).

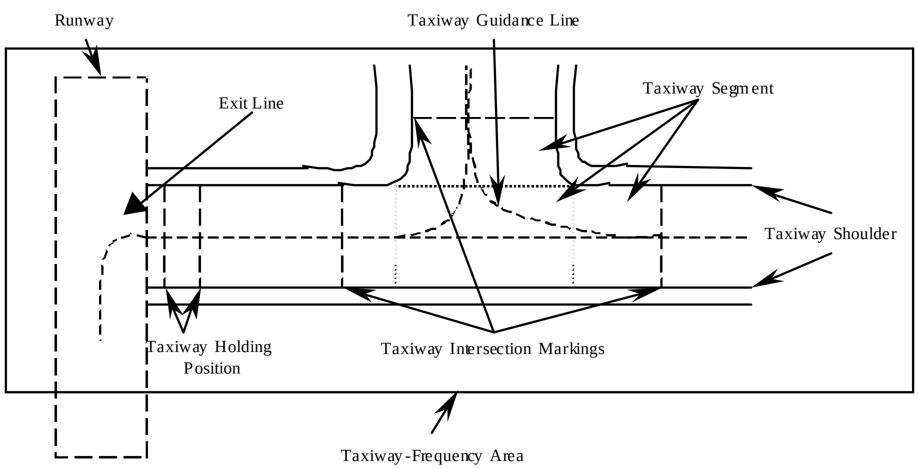

Figure 4-6 Required Taxiway Elements

4.3.3.1 Taxiway Segments

4.3.3.1.1 All taxiway segments, including taxiway, apron taxiway, rapid exit taxiway, taxiway intersection, and aircraft stand taxilane surfaces (see ICAO Annex 14, Chapter 1.1) shall be included as individual objects in the database. Taxiway segments do not include taxiway shoulders and aircraft parking/stand areas.

4.3.3.1.2 Each taxiway segment polygon shall describe the surface of a single taxiway. A single taxiway is an area identified by the same name. No taxiways shall overlap. The intersection of two taxiways shall be an individual object.

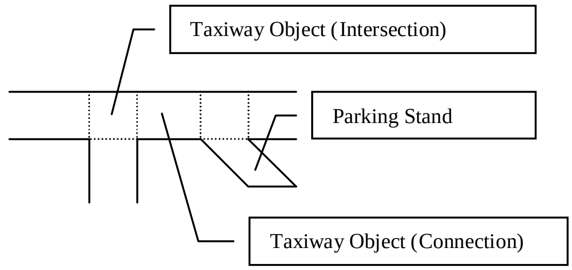

Figure 4-7 Taxiway Segments

Geometry: Polygon

Attributes:

1. Taxiway feature type identifier
2. ICAO aerodrome location indicator
3. Object identifier
4. Vertical accuracy
5. Horizontal accuracy
6. Vertical Resolution
7. Horizontal Resolution
8. Name of entity or organization that supplied data
9. Data integrity to support the end-to-end quality system from provider to end user
10. Date of last revision or generation of source data
11. Surface type of the taxiway
12. Pavement Classification Number (PCN) of taxiway

4.3.3.2 Taxiway Shoulders

4.3.3.2.1 Taxiway shoulders (see definition: ICAO Annex 14, Chapter 1.1) shall be included as individual objects in the database.

Geometry: Polygon. This can be multiple polygons forming the overall taxiway shoulder.

Attributes:

1. Taxiway shoulder feature type identifier
2. ICAO aerodrome location indicator
3. State of taxiway shoulder at day of data generation/revision: Usable (1) or Unusable (0)
4. Vertical accuracy
5. Horizontal accuracy
6. Vertical Resolution
7. Horizontal Resolution
8. Name of entity or organization that supplied data
9. Data integrity to support the end-to-end quality system from provider to end user
10. Date of last revision or generation of source data
11. Surface type of the taxiway shoulder

4.3.3.3 Taxiway Guidance Lines

Taxiway guidance lines (taxilines) are referred to in ICAO Doc. 9157 as taxiway centerlines.

4.3.3.3.1 Guidance lines painted on a taxiway (see definition: ICAO Annex 14, Chapter 5.2.8) shall be included as individual objects in the database. Each taxiline object in the database shall be a straight or curved line between two taxiline intersections. For connecting taxilines, the endpoint of one of the taxiline objects shall be the starting point of the next one as shown below.

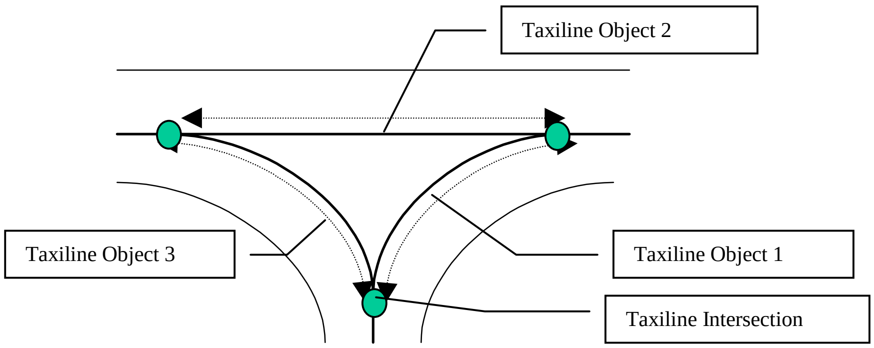

Figure 4-8 Taxiway Guidance Lines

Geometry: Line

Attributes:

1. Taxiway Guidance Line feature type identifier
2. ICAO aerodrome location indicator
3. Object identifier
4. State of corresponding taxiway segment at day of data generation/revision: open or close
5. Vertical accuracy
6. Horizontal accuracy
7. Vertical Resolution
8. Horizontal Resolution
9. Name of entity or organization that supplied data
10. Data integrity to support the end-to-end quality system from provider to end user
11. Date of last revision or generation of source data
12. Additional information about any operational restrictions not concerning the PCN (e.g., wing span clearance, speed limit)
13. Directionality of taxiline (one-way or bi-directional)

4.3.3.4 Taxiway Intersection Markings

4.3.3.4.1 Taxi intersection markings (see definition: ICAO Annex 14, Chapter 5.2.10) shall be individual objects in the database. The line shall be located in the center of the painted ground marking.

Geometry: Line

Attributes:

1. Taxiway Intersection Marking feature type identifier
2. ICAO aerodrome location indicator
3. Vertical accuracy

4. Horizontal accuracy
5. Vertical Resolution
6. Horizontal Resolution
7. Name of entity or organization that supplied data
8. Data integrity to support the end-to-end quality system from provider to end user
9. Date of last revision or generation of source data

4.3.3.5 Taxiway Holding Positions (Stopbars)

4.3.3.5.1 Taxiway holding positions (see definition: ICAO Annex 14, Chapter 5.2.9/5.3.17) shall be included as individual objects in the database. The line shall be located at the outer edge of the painted ground marking away from the corresponding runway.

Geometry: Line

Attributes:

1. Taxiway Holding Position feature type identifier
2. ICAO aerodrome location indicator
3. Low Visibility Operation Category of Holding Position
4. State of Taxiway Holding Position at day of data generation/revision operative or inoperative
5. Vertical accuracy
6. Horizontal accuracy
7. Vertical Resolution
8. Horizontal Resolution
9. Name of entity or organization that supplied data
10. Data integrity to support the end-to-end quality system from provider to end user
11. Date of last revision or generation of source data
12. Identification of corresponding runway or taxiway that is being protected

4.3.3.6 Runway Exit Lines

4.3.3.6.1 Runway exit lines shall be individual objects in the database and shall end at the first intersection of the exit line with any other taxiline.

Geometry: Line

Attributes:

1. Exit Line feature type identifier
2. ICAO aerodrome location indicator
3. Object identifier
4. Vertical accuracy
5. Horizontal accuracy
6. Vertical Resolution
7. Horizontal Resolution
8. Name of entity or organization that supplied data
9. Data integrity to support the end-to-end quality system from provider to end user
10. Date of last revision or generation of source data
11. State of Exit Line or underlying taxiway segment at day of data generation/revision: open or closed
12. Directionality of exitline (one-way or bi-directional)

4.3.3.7 Frequency Areas

4.3.3.7.1 Polygons representing designated areas on the surface where a specific frequency is required by ATC or ground control shall be individual objects in the database. If there is only one frequency area for the aerodrome, the polygon shall cover the total aerodrome area as defined in Section 3.

Geometry: Polygon

Attributes:

1. Frequency area feature type identifier
2. ICAO aerodrome location indicator
3. Vertical accuracy
4. Horizontal accuracy
5. Vertical Resolution
6. Horizontal Resolution
7. Name of entity or organization that supplied data
8. Data integrity to support the end-to-end quality system from provider to end user
9. Date of last revision or generation of source data
10. Primary frequency to use
11. Service or Station assigned to primary frequency (e.g., ATC Tower, Ground Control)

4.3.4 Aprons

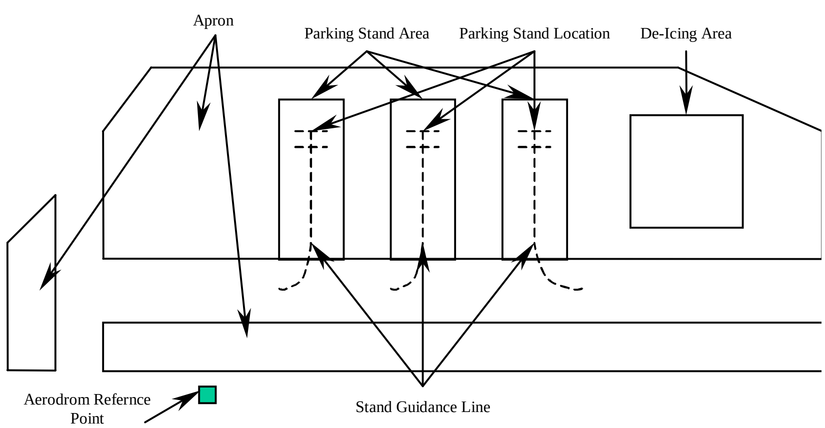

Figure 4-9 Required Apron Elements

4.3.4.1 Apron Polygons

4.3.4.1.1 Aircraft accessible apron areas (see definition: ICAO Annex 14, Chapter 1.1) that are not aircraft stands, aircraft stand taxilanes, or apron taxiways shall be individual objects in the database. The apron may consist of multiple polygons.

Geometry: Polygon

Attributes:

1. Apron feature type identifier
2. ICAO aerodrome location indicator
3. State of Apron area at day of data generation/revision usable or unusable
4. Vertical accuracy
5. Horizontal accuracy
6. Vertical Resolution

7. Horizontal Resolution
8. Name of entity or organization that supplied data
9. Data integrity to support the end-to-end quality system from provider to end user
10. Date of last revision or generation of source data
11. Additional information about any apron restrictions (e.g., wingspan limits)
12. PCN of apron
13. Surface type of the apron

4.3.4.2 Stand Guidance Lines

4.3.4.2.1 All painted taxilines covering a parking stand area are regarded as stand guidance lines and shall be individual objects in the database. There may be several stand guidance taxilines leading to an aircraft stand to accommodate different aircraft types.

Geometry: Line

Attributes:

1. Stand Guidance line shoulder feature type identifier
2. ICAO aerodrome location indicator
3. Object identifier
4. Vertical accuracy
5. Horizontal accuracy
6. Vertical Resolution
7. Horizontal Resolution
8. Name of entity or organization that supplied data
9. Data integrity to support the end-to-end quality system from provider to end user
10. State of Stand Guidance Line at day of data generation/revision: Complete or Partly Removed
11. Date of last revision or generation of source data
12. Directionality of taxiline
13. Maximal wingspan allowed on corresponding parking stand

4.3.4.3 Parking Stand Locations

4.3.4.3.1 Painted stand positions on the stand guidance line shall be individual objects in the database. These are usually marked according to aircraft type (e.g., for B-747, A-340).

Geometry: Point

Attributes:

1. Parking Stand feature type identifier
2. ICAO aerodrome location indicator
3. Object identifier
4. Vertical accuracy
5. Horizontal accuracy
6. Vertical Resolution
7. Horizontal Resolution
8. Name of entity or organization that supplied data
9. Data integrity to support the end-to-end quality system from provider to end user
10. Date of last revision or generation of source data
11. Feasibility of Parking stand location for aircraft type

4.3.4.4 Parking Stand Areas

4.3.4.4.1 Operational areas near parking stands denoted by painted markings shall be individual objects in the database.

Geometry: Polygon

Attributes:

1. Parking stand area feature type identifier
2. ICAO aerodrome location indicator
3. Object identifier
4. State of parking stand at day of data generation/revision: open or closed
5. Vertical accuracy
6. Horizontal accuracy
7. Vertical Resolution
8. Horizontal Resolution
9. Name of entity or organization that supplied data
10. Data integrity to support the end-to-end quality system from provider to end user
11. Date of last revision or generation of source data
12. Additional information about the available facilities at the parking stand (e.g., jetways, fuel, tow maintenance, docking guidance)
13. Additional information about any restrictions for the stand area (e.g., wingspan limits)
14. Pavement Classification Number (PCN) of taxiway
15. Surface type of the parking stand

4.3.4.5 Deicing Areas

4.3.4.5.1 Designated aircraft deicing areas (see definition: ICAO Annex 14, Chapter 1.1) shall be individual objects in the database.

Geometry: Polygon

Attributes:

1. Deicing Area feature type identifier
2. ICAO aerodrome location indicator
3. State of deicing area at the date of generation/revision: Operative or Inoperative
4. Vertical accuracy
5. Horizontal accuracy
6. Vertical Resolution
7. Horizontal Resolution
8. Name of entity or organization that supplied data
9. Data integrity to support the end-to-end quality system from provider to end user
10. Date of last revision or generation of source data
11. Surface type of the deicing area

4.3.4.6 Aerodrome Reference Point

4.3.4.6.1 The designated geographic location of an aerodrome (ICAO Annex 14, Chapter 1.1) as published in local AIP shall be an individual object in the database.

Geometry: Point

Attributes:

1. ICAO aerodrome location indicator
2. Vertical accuracy
3. Horizontal accuracy
4. Vertical Resolution
5. Horizontal Resolution
6. Name of entity or organization that supplied data
7. Data integrity to support the end-to-end quality system from provider to end user
8. Date of last revision or generation of source data

4.3.5 Vertical Structures

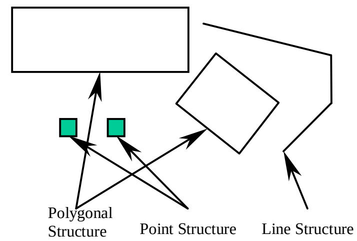

Figure 4-10 Required Vertical Structure Elements

4.3.5.1 Polygonal Structures

4.3.5.1.1 All polygonal structures (e.g., buildings) whose maximum height exceeds the defined vertical limit (see 3.11) shall be individual objects in the database.

Geometry: Polygon

Attributes:

1. Structure feature type identifier
2. ICAO aerodrome location indicator
3. Additional information about data element (e.g., regarding the use of structure, equipment)
4. State of structure at day of data generation/revision: under construction or not under construction
5. Vertical accuracy
6. Horizontal accuracy
7. Vertical Resolution
8. Horizontal Resolution
9. Name of entity or organization that supplied data
10. Data integrity to support the end-to-end quality system from provider to end user
11. Date of last revision or generation of source data
12. Maximal height of structure
13. Maximal elevation of top of structure (MSL)
14. Primary surface type of the structure

4.3.5.2 Point Structures

4.3.5.2.1 All point structures (e.g., radio towers) whose maximum height exceeds the defined vertical limit (see 3.11) shall be individual objects in the database.

Geometry: Point

Attributes:

1. Obstacle feature type identifier
2. ICAO aerodrome location indicator
3. Obstacle feature type identifier
4. Vertical accuracy
5. Horizontal accuracy
6. Vertical Resolution
7. Horizontal Resolution
8. Name of entity or organization that supplied data
9. Data integrity to support the end-to-end quality system from provider to end user
10. Date of last revision or generation of source data
11. Obstacle marking in conformance with ICAO Annex 14, Chapter 6.2
12. Obstacle lighting in conformance with ICAO Annex 14, Chapter 6.2
13. Radius of circle around center of obstacle including body of obstacle and associated structures such as guywires
14. Maximal height of point structure
15. Maximal elevation of top of point structure (MSL)
16. Surface material of the obstacle

4.3.5.3 Line Structures

4.3.5.3.1 All line structures (e.g., power lines) whose maximum height exceeds the defined vertical limit (see 3.11) shall be individual objects in the database.

Geometry: Line

Attributes:

1. Obstacle feature type identifier
2. ICAO aerodrome location indicator
3. Obstacle feature type identifier
4. Vertical accuracy
5. Horizontal accuracy
6. Vertical Resolution
7. Horizontal Resolution
8. Name of entity or organization that supplied data
9. Data integrity to support the end-to-end quality system from provider to end user
10. Date of last revision or generation of source data
11. Obstacle marking in conformance with ICAO Annex 14, Chapter 6.2
12. Obstacle lighting in conformance with ICAO Annex 14, Chapter 6.2
13. Maximal height of line structure
14. Maximal elevation of line structure (MSL)
15. Surface material of the obstacle

4.3.6 Construction Areas

4.3.6.1 Aircraft movement areas under construction shall be individual objects in the database (see 3.7).

Geometry: Polygon

Attributes:

1. Construction Area feature type identifier
2. ICAO aerodrome location indicator

3. Vertical accuracy
4. Horizontal accuracy
5. Vertical Resolution
6. Horizontal Resolution
7. Name of entity or organization that supplied data
8. Data integrity to support the end-to-end quality system from provider to end user
9. Date of last revision or generation of source data

4.3.7 Quality Data

The following data elements are needed to support quality assurance.

4.3.7.1 Survey Control Points

4.3.7.1.1 Locations of monumented survey control points at the aerodrome (ICAO Doc 9674 WGS84 Manual, Chapter 5.2.5) shall be individual objects in the database. In the US, these are known as PACS.

Geometry: Point

Attributes:

1. Survey Control Point feature type identifier
2. ICAO aerodrome location indicator
3. Vertical accuracy
4. Horizontal accuracy
5. Vertical Resolution
6. Horizontal Resolution
7. Name of entity or organization that supplied data
8. Data integrity to support the end-to-end quality system from provider to end user
9. Date of last revision or generation of source data
10. Reference-Coordinates of Survey Point
11. Horizontal datum of Reference Coordinates
12. Vertical Datum of Reference Coordinates
13. Spheroid of Reference Coordinate
14. Projection of Reference Coordinates

4.4 Supplemental Data Elements

The following elements are not required, but can be useful to some applications.

- INS and VOR Checkpoints
- Noise Abatement Zones
- Special Use Areas
- Turning Pads at Runway Ends
- Aerodrome Service Roads
- Aerodrome Surface Lighting
- Aerodrome Signage
- Aerodrome Boundary

4.5 Integrity

For the purposes of this document, integrity classification is consistent with ICAO's WGS-84 Manual.

1. Critical data – there is a high probability when using corrupted critical data that the continued safe operation of an aircraft would be severely at risk with potential for catastrophe. Required level of data integrity is 10^{-8} or better.

2. Essential data – there is a low probability when using corrupted essential data that the continued safe operation of an aircraft would be severely at risk with potential for catastrophe. Required level of data integrity is 10^{-5} or better.
3. Routine data – there is a very low probability when using corrupted routine data that the continued safe operation of an aircraft would be severely at risk with the potential for catastrophe. Required level of data integrity is 10^{-3} or better.

4.5.1 Data originators and integrators shall ensure that the integrity of aerodrome data is maintained throughout the data process from survey/origin to the end user.

4.5.2 Because required data integrity depends to a large degree on the application of that data (or how it is used) and a detailed Functional Hazards Analysis, required integrity is not listed for each data element. However, for these elements, one of the above integrity categories shall be used.

4.5.3 For those data elements that are already required to support air navigation[1], integrity requirements from those documents shall be used and are listed in Tables 4-1 through 4-4.

4.6 Numerical Requirements

Tables 4-1 through 4-4 list data quality requirements for three categories of AMDB data: *Coarse, Medium,* and *Fine*.

Coarse data information requirements would be the minimum acceptable data quality. Coarse quality data may support only a few of the applications described in Appendix A for a given aerodrome such as electronic charting. This data would generally support criteria for VFR and special-night VFR (helicopter) operations, primarily at GA uncontrolled aerodromes. It is expected that data meeting Coarse requirements may be obtained from a single source (e.g., imagery or CAD drawings).

Medium data information requirements would support most of the aviation applications described in Appendix A for a given aerodrome including the cockpit display of traffic information (CDTI). This data would support non-precision approach capability (e.g., VOR, NDB, and GNSS approaches). Medium data requirements may be met using imagery from commercial space systems or aircraft without ground control utilizing overlapping imagery; and/or through photogrammetric analysis utilizing a stereoscopic model.

Fine data information requirements would support all aviation applications described in Appendix A for a given aerodrome including low visibility surface navigation. This data would support all-weather flight operations including conditions when Category I, II, or III precision approaches are being flown. The most stringent approach criteria at the aerodrome will generally establish a need for Fine survey data. Acquiring this class of data would probably require ground control points (surveys) and the use of photogrammetric techniques in conjunction with imagery.

4.6.1 The Data Derivation column in Tables 4-1 through 4-4 refers to either Surveyed (S), Calculated (C), or *as charted*. If available, a surveyed value shall be used instead of a calculated or *as charted* value.

4.6.2 In Tables 4-1 through 4-4, the three columns under *Fine*, *Medium*, and *Coarse*, list requirements for accuracy (A), resolution (R), and integrity (I), respectively. As stated previously, integrity requirements (either C, E, or R) are listed only for those elements

[1] RTCA DO-201A/ED-77, Standards for Aeronautical Information.

already required for air navigation. For these elements, the quality requirements are simply copied from the relevant ICAO documents to show consistency.

Table 4-1 Horizontal Data Quality Requirements

(All values in meters; NR denotes not required)

Data Element	Data Derivation	Fine			Medium			Coarse		
		A	R	I	A	R	I	A	R	I
Runway	S	1	0.1	C	5	0.1	-	30	1	-
Runway threshold	S	1	0.1	C	5	0.1	-	NR	NR	-
Runway centerline	S	0.5	0.01	-	NR	NR	-	NR	NR	-
LAHSO location	S	1	0.1	R	3	0.1	-	NR	NR	-
Arrest gear location	S	1	0.1	-	5	0.1	-	30	1	-
Runway shoulder	S	1	0.1	-	5	0.1	-	30	1	-
Stopway	S	1	0.1	-	5	0.1	-	30	1	-
Clearway	S	1	0.1	-	5	0.1	-	30	1	-
Runway marking	as charted	NR	NR	-	NR	NR	-	NR	NR	-
FATO	S	1	0.1	-	3	0.1	-	5	0.1	-
TLOF	S	1	0.1	-	3	0.1	-	5	0.1	-
Helipad threshold	S	1	0.1	C	5	0.1	-	NR	NR	-
Taxiway segment	S	1	0.1	-	3	0.1	-	5	0.1	-
Taxiway shoulder	S	1	0.1	-	3	0.1	-	5	0.1	-
Taxiway guidance line	S	0.5	0.01	C	NR	NR	-	NR	NR	-
Taxiway intersection marking	S	0.5	0.01	C	NR	NR	-	NR	NR	-
Taxiway holding position	S	1	0.1	-	5	0.1	-	NR	NR	-
Exit line	S	0.5	0.01	C	NR	NR	-	NR	NR	-
Frequency area	C	NR	NR	-	NR	NR	-	NR	NR	-
Apron	S	1	0.1	-	5	0.1	-	30	1	-
Stand guidance line	S	0.5	0.01	E	NR	NR	-	NR	NR	-
Parking stand location	S	0.5	0.01	E	5	0.1	-	30	1	-
Parking stand area	C	1	0.1	-	5	0.1	-	30	1	-
Deicing area	S	1	0.1	-	5	0.1	-	30	1	-
Vertical polygonal objects	S	1	0.1	-	5	0.1	-	30	1	-
Vertical point objects	S	1	0.1	-	5	0.1	-	30	1	-
Vertical line objects	S	1	0.1	-	5	0.1	-	30	1	-
Construction area	S	1	0.1	-	3	0.1	-	5	0.1	-
Aerodrome reference point	C	30	1	R	30	1	R	30	1	R
Survey control point	S	0.5	0.01	E	NR	NR	-	NR	NR	-
Aerodrome boundary	C	NR	NR	-	NR	NR	-	NR	NR	-

Table 4-2 Vertical Data Quality Requirements

(All values in meters; NR denotes not required)

Data Element	Data Derivation	Fine			Medium			Coarse		
		A	R	I	A	R	I	A	R	I
Runway threshold (non-precision)	S	0.5	0.1	E	NR	NR	-	NR	NR	-
Runway threshold (precision)	S	0.25	0.01	C	NR	NR	-	NR	NR	-
Runway centerline	S	1	0.1	-	NR	NR	-	NR	NR	-
Taxiway guidance line	S	1	0.1	-	NR	NR	-	NR	NR	-
Survey control point	S	0.25	0.01	E	NR	NR	-	NR	NR	-
Threshold ellipsoidal elevation (non-precision)	S	0.5	0.1	E	NR	NR	-	NR	NR	-
Threshold ellipsoidal elevation (precision)	S	0.25	0.01	C	NR	NR	-	NR	NR	-
Maximal height of vertical object	C	1	0.1	-	1	0.1	-	1	0.1	-
Maximal elevation of vertical object	S	1	0.1	-	1	0.1	-	1	0.1	-
Touchdown zone elevation	S	1	0.1	-	1	0.1	-	1	0.1	-

Table 4-3 Angular Data Quality Requirements

Data Element	Data Derivation	Fine			Medium			Coarse		
		A	R	I	A	R	I	A	R	I
True runway bearing	C	0.1°	0.01°	R	0.5°	0.01°	-	1.5°	0.1°	-
Magnetic runway bearing	S	0.1°	0.01°	R	0.5°	0.01°	-	1.5°	0.1°	-

Table 4-4 Dimensional Data Quality Requirements

(All values in meters unless otherwise stated; NR denotes not required)

Data Element	Data Derivation	Fine			Medium			Coarse		
		A	R	I	A	R	I	A	R	I
Width of runway	C	0.5	0.01	R	1	0.1	-	5	0.1	-
Length of runway	C	1	0.1	E	5	0.1	-	30	1	-
Touchdown zone longitudional slope	C	0.1%	0.01%	-	NR	NR	-	NR	NR	-
Runway slope	C	0.1%	0.01%	-	NR	NR	-	NR	NR	-
Take-off run available	C	1	0.1	E	5	0.1	-	30	1	-
take-off distance available	C	1	0.1	E	5	0.1	-	30	1	-
Accelerating-stop-distance available	C	1	0.1	E	5	0.1	-	30	1	-
Landing distance available	C	1	0.1	E	5	0.1	-	30	1	-
Radius of circle about center of obstacle	S	1	0.1	-	5	0.1	-	30	1	-
Maximal height of point structure	C	1	0.1	-	5	0.1	-	30	1	-

Table 4-5 Maximum Acceptable Error for Selected Fine Data Elements

(All values in meters)

Data Element	Max Error
Latitude and longitude	
Runway threshold	3
Runway centerline	2
LAHSO location	3
Taxiway guidance line	2
Taxiway holding position	3
Exit line	2
Stand guidance line	2
Parking stand location	2
Elevation	
Runway threshold (precision)	1
Runway centerline	1
Taxiway guidance line	1

Appendix A

APPLICATIONS OF AERODROME MAPPING DATABASES

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Appendix A—APPLICATIONS OF AERODROME MAPPING DATABASES

A.1 Introduction

This appendix provides an overview of the types of applications that may make use of aerodrome mapping databases. These application categories have been used to generate the requirements for the content, origination, publication, updating, and enhancement of the aerodrome mapping data that have been included in the main body of this document.

Many of the applications described herein are intended primarily to improve the user's situational awareness (SA) and/or to supplement surface navigation, thereby increasing safety margins and operational efficiency. Because the human factors term "Situational Awareness" (SA) is somewhat vague, more specific operational benefits will be listed for each application. All of these specific benefits can be considered as contributing to overall improved SA for the user (e.g., pilots, controllers, aerodrome planners and managers). Below is a definition of SA.

Definition: Situational Awareness (SA) is the perception of elements in the environment, the comprehension of their meaning, and the projection of their status into the near future[1].

For pilots, the notional concept is that situational awareness includes three fundamental elements: factors affecting the pilot's physical and emotional state; factors affecting the aircraft and its airworthiness; and last, all factors *external* to the aircraft. These external factors include situational awareness of where you are with respect to terrain and obstacle hazards, adverse weather, traffic, and wake vortex hazards.

This appendix consists of the following sections: Section A.2 provides background information with respect to relevant ICAO, EUROCAE, and RTCA activities. Section A.2 also provides an overview of aerodrome surface operations. Section A.3 consists of a summary table listing the applications to be discussed. Sections A.4 through Section A.15 provide brief descriptions of twelve potential applications of aerodrome mapping databases. Each of these sections describes the operational concept and the potential benefits that can be achieved. Finally, Section A.16 briefly introduces a technology that has the potential to implement many of the applications of AMDBs.

A.2 Background

A.2.1 Related ICAO, EUROCAE, and RTCA Activities

ICAO and EUROCAE have defined operational requirements for Advanced Surface Movement Guidance and Control Systems (A-SMGCS)[2,3] that specify what is required to support safe, orderly, and expeditious movement of aircraft and vehicles at aerodromes under all visibility conditions, traffic densities, and aerodrome layouts. These requirements were written to ensure standardization and safety with respect to global interoperability.

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[1] Endsley, M., "Design and Evaluation for Situation Awareness Enhancement", Proceedings of the 32nd Annual Meeting of the Human Factors Society, pp. 97-101, Santa Monica, CA, 1988.

[2] "Draft Manual of Advanced Surface Movement Guidance and Control Systems (A-SMGCS)", 16th Meeting of the International Civil Aviation Organization's All Weather Operations Panel, Montreal, Canada, June, 1997.

[3] "Minimum Aviation System Performance Specification for Advanced Surface Movement Guidance and Control Systems (A-SMGCS)", EUROCAE ED-87A, January 2001.

Specific recommendations are made by ICAO for improving aerodrome surface operations. Some of these are listed below.

- Improved means of providing situational awareness information to pilots, controllers and vehicle operators
- Clearly defined roles and responsibilities that eliminate procedural ambiguities that lead to operational errors and deviations
- Improved guidance and procedures should be in place to allow safe operations regardless of visibility, traffic density, and aerodrome layout
- Conflict prediction and/or detection, analysis, and resolution should be provided
- All users should be provided with the same level of service while operating on the aerodrome surface

A standardized aerodrome mapping database, available to all aerodrome users, would allow implementation of many of these recommendations as will be described in later sections.

The ICAO A-SMGCS document forecasts that the projected growth in flight operations will lead to increased surface congestion and system delay unless new techniques (e.g., technologies) are available to ATC to reduce workload. In addition, apron controllers and flight dispatch services will require greater sharing of information to manage the availability of stands and parking areas. Finally, for pilots, supplemental guidance information will be required, particularly under low visibility conditions to avoid increasing workload as the traffic volume grows.

RTCA has published DO-247 "The Role of GNSS in Supporting Aerodrome Surface Operations[4]". Although this document is intended to further develop the performance standards applicable to GNSS equipment for use on the aerodrome surface, it also suggests that GNSS-derived information (i.e., position, velocity, and time) combined with a suitable aerodrome database and display can be used to provide pilots and vehicle drivers with situational awareness and electronic guidance.

RTCA's Special Committee has drafted "Operational Concepts, Procedures, and Information Requirements for the Cockpit Display of Traffic Information (CDTI) Applications[5]". One of the applications included is "aerodrome surface CDTI to improve pilot situational awareness". This application requires an aerodrome mapping database, for the overlay of surveillance data, to achieve maximum potential.

A.2.2 Overview of Aerodrome Surface Operations

Traditionally, pilots have relied on visual aids such as airfield markings (e.g., painted centerlines), signs, and lighting, in conjunction with a paper chart of the aerodrome to navigate from point to point on the aerodrome surface. Radio communication with air traffic control (ATC) is used by pilots to obtain the route to follow while on the surface. As a rule, a "ground" controller will issue route instructions to pilots using explicit instructions and a strict protocol (i.e., phraseology) so that there is no misunderstanding of voice communications exchanged over the radio channel. The pilot must then memorize this route (or write it down), re-state it to the controller for confirmation, and then follow the signs and markings to the destination while avoiding other surface traffic and obstructions. Meanwhile, the ground controller must remember the routes given to all aircraft, as well as all aircraft locations, so that no-one is directed into a potential collision. If there is a poten-

[4] "The Role of GNSS in Supporting Aerodrome Surface Operations", DO-247, RTCA, January, 1999.

[5] "Operations Concepts, Procedures, and Information Requirements for CDTI Applications", Draft, RTCA SC-186, Working Group 1, June, 1998.

tial for collision, hold in position and/or hold-short instructions can be issued over the radio frequency to further constrain aircraft movements.

Surveillance on the aerodrome surface is performed by the flight crews based primarily on the “see and be seen” principle to maintain safe separation. Similarly, ATC performs the surveillance task based primarily on visual cues. Occasionally, both pilots and controllers will use radio communications to confirm positions of relevant traffic (e.g., “Delta 635, say your position”). While the Traffic Alerting and Collision Avoidance System (TCAS) provides traffic advisories to flight crews in flight, it is not intended for use on the aerodrome surface. The Aerodrome Surface Detection Equipment (ASDE-3) radar is used in the U. S. to provide secondary surveillance data to the ATC tower; however, it is currently only scheduled to be deployed at 34 U. S. aerodromes. ASDE-X, a follow-on airport surveillance system, is intended for deployment at an additional 25 towered airports.

These traditional procedures have worked well as aerodrome surface has not been congested and visibility is usually good. However, as traffic volume has increased, the surface is becoming more and more congested, even in clear weather, and there is a need to perform more operations in low visibility and at night to meet an ever increasing demand leading to increasingly complex, large aerodrome layouts.

In order to support flight operations at aerodromes, several other activities are required, each of which are performed by separate organizations or facilities. These include:

1. Aerodrome operations. The aerodrome authority is responsible for construction and maintenance of aerodrome resources such as buildings, pavement, lighting, markings, and landing systems (e.g., ILS). They are also responsible for providing emergency response teams such as fire/rescue and aerodrome security in some cases.
2. Commercial/Cargo airline operations. This includes a wide variety of activities such as apron control, aircraft maintenance/fueling, baggage/cargo handling, catering services, crew and aircraft scheduling, flight planning, and ticketing. This also includes training activities such as flight simulations to maintain pilot currency.
3. General Aviation (GA) and Business Aviation operations. In the U. S., these operations are typically supported by Fixed Base Operators (FBOs). FBOs support GA and business aviation operations by providing maintenance, fueling, flight planning, and local ground transportation services. FBOs are typically located away from the commercial concourse/stand areas while still having access to active taxiways and runways.

These three general classes of aerodrome activities in conjunction with pilot and ATC activities represent aerodrome surface operations at the larger aerodrome facilities. At smaller aerodrome facilities, only a subset of these activities are necessary to support surface operations.

A.3 List of Applications

Based on the availability of a standardized aerodrome mapping database, a wide variety of applications can be envisioned. Twelve are described in this document. These applications are listed below and separated by user class. Note that several of the applications can be used by multiple user classes. Each application is described in greater detail in Sections A.4 through A.15.

Pilots

Section A.4	Chart information
Section A.5	Surveillance and conflict/runway incursion detection/alerting
Section A.6	Route/hold-short depiction and deviation detection/alerting
Section A.7	Depiction of digital ATIS information

Section A.8	Aerodrome surface guidance/navigation
Section A.13	Runway operations
Section A.14	Notices to Airmen (NOTAMs) and Aeronautical Data Overlays

Air Traffic Controllers

Sections A.4, A.5, and A.6

Airline, Cargo, GA, and Business Aviation Operations

Sections A.4, A.5, A.6, and A.7

Section A.9	Resource management
Section A.10	Training and High Fidelity Simulation

Vehicle Operators

Sections A.4, A.5, A.6, A.7, A.8, A.10, and A.14

Aerodrome Operations

Section A.11	Aerodrome facility management
Section A.12	Emergency and security service management
Section A.15	Aerodrome Asset Management

A.4 Charting Information

A.4.1 Operational Concept

For pilots, a graphical depiction of the aerodrome site (including airfield movement/non-movement areas) is essential to safe and efficient navigation. Currently, this graphical depiction is provided to flight crews by way of paper charts. An alternate, or supplemental means, of graphically depicting aerodromes is by way of a flight deck electronic display. This would provide a tool for pilots to visualize their physical environment while on the aerodrome surface, or while planning an arrival to a specific aerodrome. This tool could also provide access to aerodrome-specific data that are also included in paper charts such as frequencies, operational constraints, and local procedures. In addition, such a display system could make use of a spatial database that included themes, or layers, that would allow pilots to assimilate specific displayed information types with the out-the-window scenes. These themes can include:

Runways	Taxiways	Aprons
Shoulders	Service Roads	Stands
Hold Lines/Points	Paint Features	Jetways
Pavement Segments	Centerlines	Contour Lines
Hydrography	Building/Structures	Fences
Radar sites	Elevation Models	Signage
Lighting	SMGCS Plans	Obstacles
Navigation Points	Survey Control Points	Concourses
Highways	Primary Roads	Secondary Roads
Land Use	De-Icing Pads	Land Fills

The above table highlights a list of terrestrial physical features that can be surveyed and stored in a database. The database may also support multiple spatial models, or polygonal zones. Polygonal zones are 2-D and/or 3-D shapes used to provide spatial cueing or visualization of data by way of illustration. A list of themes that support various modeling constructs is presented in the following table:

Noise Contours	Incursion Zones	Movement Areas
Airspace Cylinders	Ground Water Models	De-Ice Solvent Plumes
Bird Strike Areas	ILS Hold Segments	Tower Field of View
Emergency Response Time/ Distance Zones	Approach/Departure Corridors	Obstacle buffer zones

This application of aerodrome databases does not require any interfaces to real-time data and could operate on a "stand-alone" basis in the flight deck.

A.4.2 Benefits

In addition to the graphical depiction of the aerodrome layout, spatial and tabular information included in the database could be utilized as a source of Aerodrome/Facility Directory data, NOTAM data, communications frequencies, procedures, and other textual annotation information overlaid on graphics/maps that have customarily been included in the charts/ manuals. Information would be made available in electronic format eliminating the need for paper copies of maps and charts in most instances. For pilots, this would reduce cockpit clutter and workload during surface operations and ease flight planning activities. Electronic charting information may also be used by other aerodrome users to support:

- Aerodrome operations and facilities management
- Planning (e.g., environmental, noise, construction, etc.)
- Leases, pavement utilization, utilities, snow removal, etc.
- Airline/Cargo/GA resource management
- ATC and apron control, routing, dispatch, and decision support tools
- Efficient routing of aircraft and vehicles; conflict detection and alerting
- Emergency response and security operations

Finally, database chart information, developed in electronic form and distributed on electronic media and/or via network (or the world-wide web) connectivity, can be maintained and disseminated in an efficient, cost-effective manner to the pilot/user community.

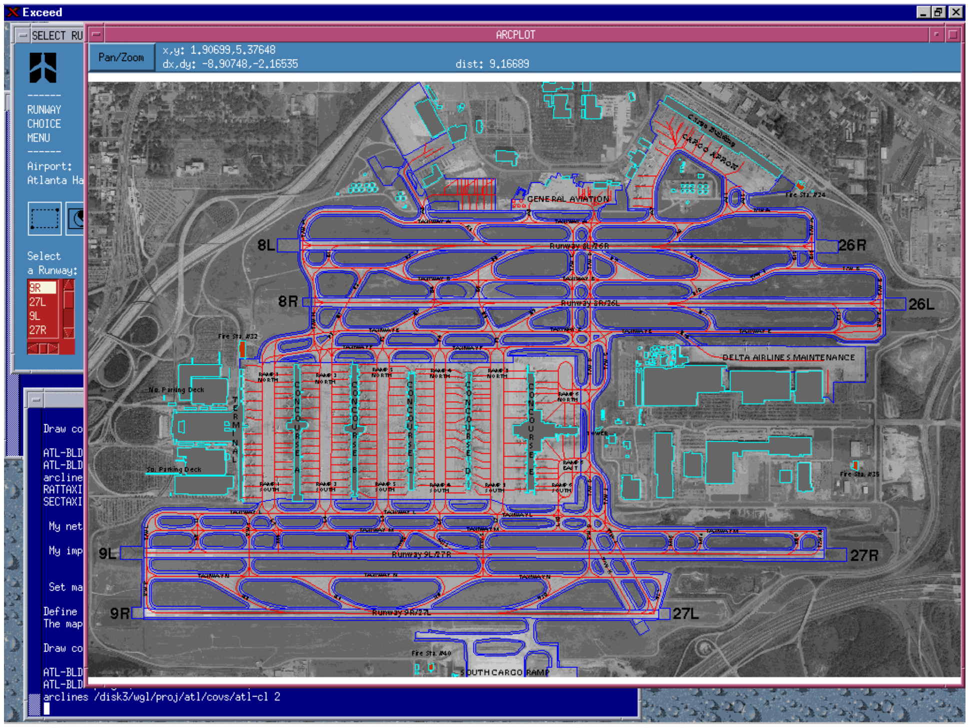

Figure A-1 GIS Depiction of ATL

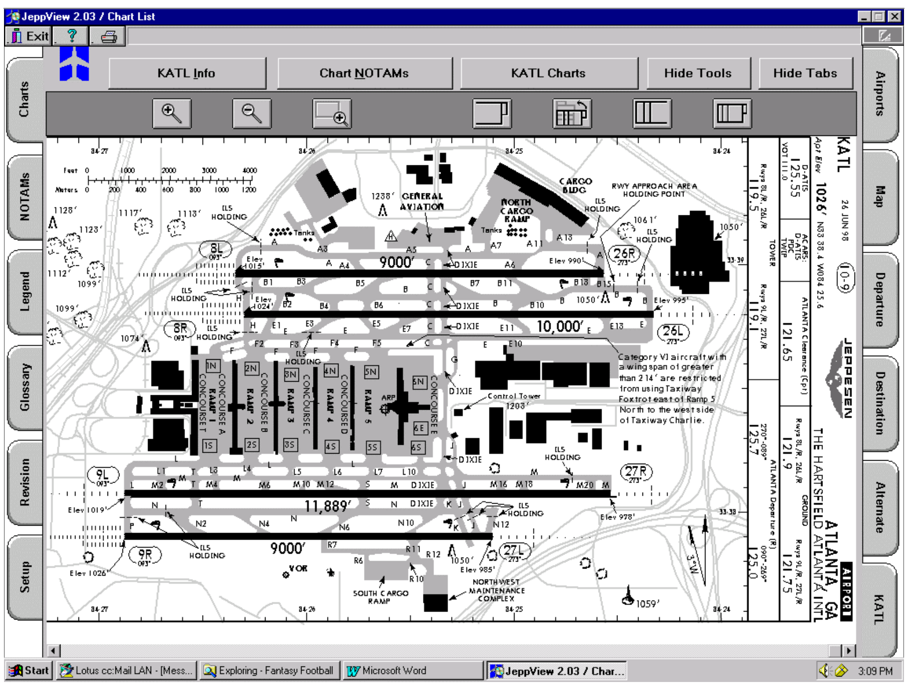

Figure A-2 Sample of Charting Information Display

A.5 Surveillance and Conflict (Runway Incursion) Detection and Alerting

A.5.1 Operational Concept

In today's environment, flight crews maintain traffic awareness on the surface by way of frequent visual scans and, in some cases, radio communications with air traffic control (ATC) to obtain traffic advisories. Except for a few rare runway/taxiway geometry's (obtuse-angled intersections) and high-workload situations, this method of surveillance is adequate during VMC. However, as weather conditions deteriorate (i.e., IMC), at night, or under high workload conditions, maintaining awareness of traffic on the surface can become increasingly difficult. In these types of situations, uncertainties can arise that, in the best case, reduce flow rates, and in the worst case, increase the likelihood of a runway incursion and/or surface accident.

Real-time aerodrome surface surveillance data is available (via ASDE-3 radar) at certain U. S. aerodromes. This ground-based surveillance data has been provided to ATC to supplement visual acquisition. Used in conjunction with an automation system, ASDE-3 can detect potential hazardous situations on the aerodrome surface. This automation is called the Aerodrome Movement Area Safety System (AMASS). AMASS provides ATC with alerts and warnings of unsafe traffic conditions. Both systems (ASDE-3 and AMASS) utilize an aerodrome mapping database. The database is used by the ASDE-3/AMASS to depict the locations of traffic with respect to runway/taxiway edges and to detect runway incursions. This database is not standardized and its format is proprietary in nature. Further, the database does not lend itself to reuse by other user classes as it uses the radar's polar coordinate system (range, azimuth), which is relative to the ASDE-3's rotating radar antenna location.

Figure A-3 Aerodrome Movement Area Safety System (AMASS) Display[6]

With the advent of ADS-B and TIS-B data link services, surveillance data will become available to non-ATC users (e.g., pilots) throughout all phases of flight (including aerodrome surface operations), and even at non-towered aerodromes. Users of this surveil-

[6] Photo provided by the Federal Aviation Administration.

lance data, along with an accurate, complete, aerodrome mapping database can then be provided with a supplemental means of observing traffic positions on the aerodrome surface in any visibility condition on a graphical display (much like ATC use of ASDE-3/AMASS). This overlay of traffic data onto a graphical depiction of the aerodrome will allow the user to determine own-ship location as well as the relative location, velocity, identity, and intent of all aircraft/vehicles on the movement area (see Figure A-4 through Figure A-8). This application has been identified in the MASPS for ADS-B and has been demonstrated in flight on transport-category aircraft at major aerodrome facilities[7][8].

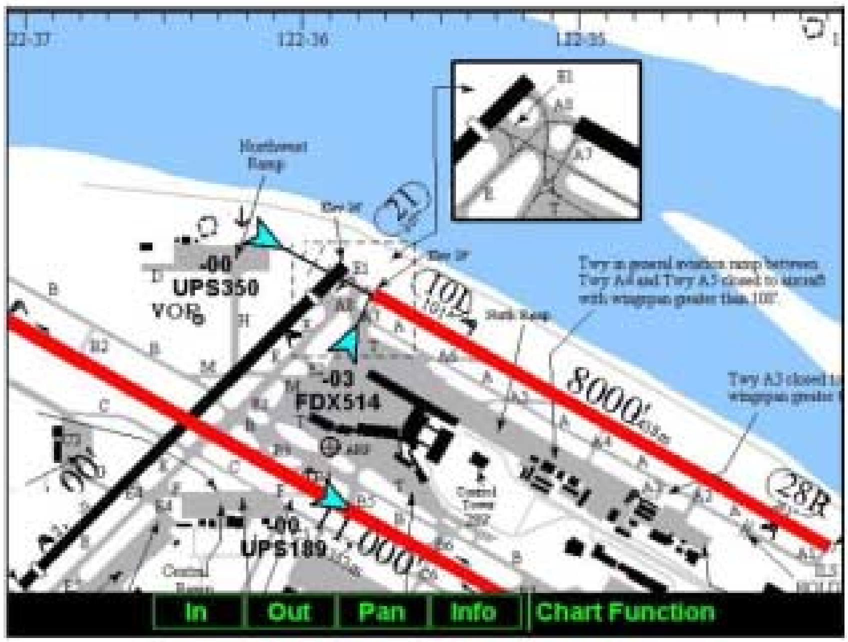

Figure A-4 Cockpit Display of Surface Traffic[9]

In addition, runway incursions and potential surface collisions can be detected and presented in the cockpit using a graphical depiction of the aerodrome once surveillance data and an aerodrome mapping database are available. Once detected, alerts can be issued to either ATC (via data link) or directly to the flight crew. This detection and alerting can be functionally similar to the approach taken by AMASS and/or TCAS. This runway incursion alerting concept has undergone flight simulation testing at NASA and flight testing at the Dallas-Ft. Worth International Airport[10]

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[7] "Minimum Aviation Systems Performance Standards (MASPS) for Automatic Dependent Surveillance – Broadcast", DO-242, RTCA, 1998.

[8] Young, S., and Jones, D., "Flight Testing of an Aerodrome Surface Movement Guidance, Navigation, and Control System", Proceedings of the Institute of Navigation's National Technical Meeting, January 21-23, 1998.

[9] Photo provided by the Federal Aviation Administration.

[10] Young, S., and Jones, D., "Runway Incursion Prevention Using an A-SMGCS", Proceedings of the 19th Digital Avionics Systems Conference, October 7-13, 2000.

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Figure A-5 **Perspective Map Display with Traffic and Route Information**

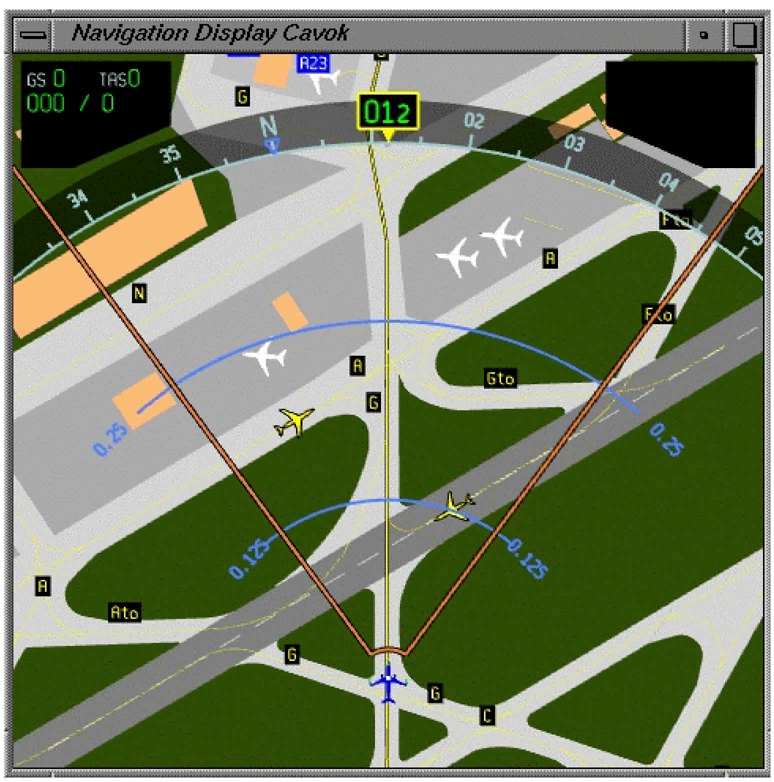

Figure A-6 **Plan-view Map Display**

Figure A-7 **Map Display with Runway Incursion Alerting on Final Approach**

Figure A-8 **Ego-centric Display Showing 3D Aircraft Silhouette Depictions**

A.5.2 Benefits

For pilots, access to a Cockpit Display of Traffic Information (CDTI) during surface operations at controlled and uncontrolled aerodromes can increase traffic awareness while decreasing the uncertainties associated with available visual cues and radio communications[11]. This increased awareness can:

- Reduce the likelihood of runway incursions and surface accidents
- Reduce the likelihood of navigation errors on the surface
- Enable tighter separations on the surface and higher taxi speeds
- Enable strategic planning to avoid departure queues
- Enable strategic planning by choosing an optimum runway exit
- Reduce the amount of radio communications required

Further, in extremely low visibility conditions (e.g., Category III-B and III-C), surface CDTI can become an enabling technology. Despite the fact that autoland and HUD systems allow Category III-B landings, these operations are not permitted at VMC flow rates, in large part, because flight crews cannot safely perform “see-and-avoid” while moving on the aerodrome surface. A surface CDTI capability would be critical in enabling higher capacity IMC flow rates on the aerodrome surface.

Finally, it should be noted that, frequently, ATC surface guidance is provided to flight crews relative to other surface vehicles. For example, “Delta 625, follow company traffic” or “American 833, follow the 737 to your left”. A surface CDTI capability would support adherence to these types of instructions in limited visibility as well as reinforcing uncertainties that may occur when these types of instructions are issued in VMC.

As mentioned earlier, ATC can also benefit from the use of aerodrome mapping databases to depict the geographic locations of aerodrome surface traffic. This is being implemented at major U. S. aerodromes by the ASDE-3 radar system. ASDE-3 is used as a supplemental means of surveillance for controllers working in the tower; it is used more extensively as weather conditions deteriorate. AMASS works in conjunction with the ASDE-3 radar to provide controllers with automatic alerts and warnings of runway incursions and other potentially hazardous situations. ASDE-3/AMASS is an entirely passive system that does not require any equipage on vehicles or aircraft.

Airline, cargo, GA, and business aviation operations centers could also benefit from real-time surveillance data depicted on a graphical aerodrome mapping database. This capability would enable more efficient operations. For example, apron controllers can make more informed decisions about controlling the movement of aircraft and vehicles in the apron areas to avoid conflicts and to reduce delays. Also, scheduling and managing service vehicle operations (e.g., fuel, baggage, etc.) can be improved by tracking the location of vehicle and aircraft locations.

As with pilots, the primary benefit to vehicle operators of a display of traffic information superimposed onto an aerodrome mapping database is to reduce the likelihood of runway incursions or surface accidents. Low-cost prototype systems have been tested on vehicle platforms (e.g., emergency vehicles) that have shown the potential for this application[12]. Also, fire and rescue vehicles in particular can benefit significantly from this technology. This application would allow them to accurately discern the location of accidents and choose the fastest route to the scene avoiding other surface traffic.

[11] Young, S., and Andre, A., "Cockpit Display of Traffic Information (CDTI) for Improved Aerodrome Surface Situational Awareness", submission to RTCA SC-186, Working Group 3, for inclusion in the Minimum Operational Performance Standards (MOPS) for CDTI, March, 1998.

[12] Teeter, R., et. al., “Voice Activated Poor-Visibility Emergency Response System (VAPERS)”, Orbital Technologies, U. S. Air Force Contractor Report, Tyndall Air Force Base, February, 1995.

A.6 Route and Hold-short Depiction and Deviation Detection and Alerting

A.6.1 Operational Concept

In today's aerodrome environment, both departure and arrival taxi routes are provided by ATC to the flight deck by way of VHF voice radio communication. All taxi route instructions are "read-back" by the responsible flight deck crewmember to ATC as a way of confirming the instruction. Similarly, hold-short instructions are also issued by ATC to constrain aircraft movements to avoid surface collisions, runway incursions, or ILS interference. In the flight deck, taxi routes are memorized (and sometimes written down). Subsequently, the pilots follow relevant signage to reach the destination stand or runway. For arrivals, taxi routes are typically requested by the flight deck after clearing the arrival runway. For departures, taxi routes are typically requested just prior to entering the movement area (on departure from the ramp/apron).

For this application, taxi routes would be depicted on a graphical display of the aerodrome layout. There are several ways in which this route could be represented (Figure A-9 and Figure A-10). Figure A-9 depicts the taxi route as a magenta line similar to the way in which it is done on navigation displays in flight. Figure A-9 also depicts a method of graphically representing hold-short instructions. Red bars at ATC-designated hold points would also be displayed on the aerodrome map. These bars are removed once ATC has cleared the aircraft to continue taxi. These methods have been flight tested and shown to be effective. Taxi routes and hold-short locations can either be transmitted to the aircraft, stored in a database onboard the aircraft using a standard naming convention, or entered by the crew.

Figure A-9 Perspective View

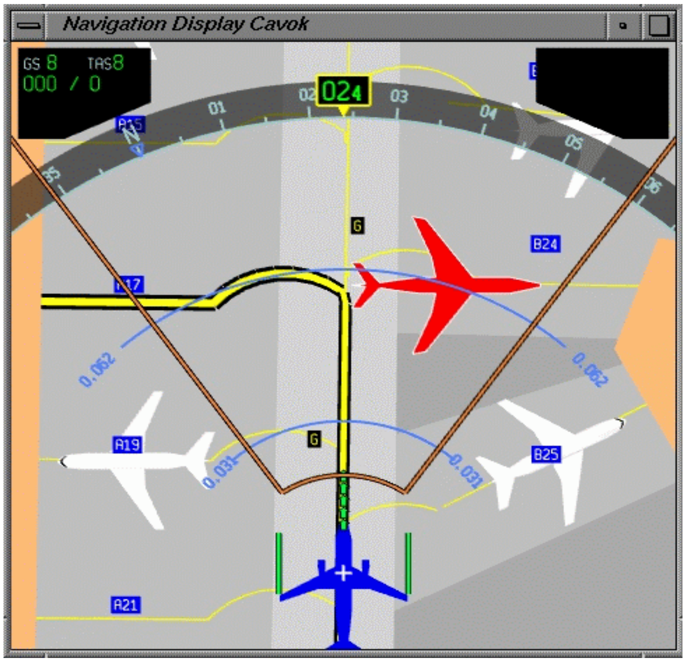

Figure A-10 Plan View

A.6.2 Benefits

A graphic depiction of taxi route and hold-short location has been shown to reduce the likelihood of pilots making navigation errors (i.e., wrong turns or runway incursions) on the aerodrome surface, while at the same time enabling an increase in taxi speed[13]. This is primarily due to the fact that uncertainties associated with both the visual aids (i.e., signage), and radio communications, are significantly reduced. Another contributing factor to this benefit is that the graphic depiction of route and hold-short location is a more natural representation than a series of alpha-numeric symbols which are either memorized or written down.

Depending on the implementation of this application, other operational benefits are achievable. If taxi route and hold-short locations are data linked to the flight deck via CPDLC, the probability of miscommunication and/or misunderstanding over the voice channel can be reduced. The CPDLC instructions would serve as a reinforcement for voice communications. This would also reduce the amount of voice traffic on the radio channel as the number of “say agains” and progressive taxi instructions (to pilots unfamiliar with the aerodrome) would be reduced. On the other hand, if taxi routes were entered in the flight deck (or chosen from a menu of standard routes) by the crew after receipt via radio, the operational benefits would still be achievable as well as removing the workload of “writing” and/or memorizing routes and/or hold-short locations.

Finally, by knowing the assigned route, hold-short locations, and one’s own-ship position, it becomes possible to monitor route conformance during the surface operation. Deviations from route, or moving beyond a hold point, can be detected and alerts can be sent to the crew, ATC, or even other aircraft that may be impacted. Advisories can be generated that would return the aircraft to its route in a direct safe manner.

[13] McCann, R., et. al., “An Evaluation of Taxiway Navigation and Situation Awareness (T-NASA) System in High-Fidelity Simulation”, Proceedings of the AIAA/SAE World Aviation Congress, September, 1998.

A.7 Depiction of Digital ATIS Information

A.7.1 Operational Concept

Listed below is a typical message received in the flight deck via the Automatic Terminal Information Service (ATIS). Digital ATIS messages are either pre-recorded and replayed over a radio frequency, or encoded and transmitted digitally to equipped aircraft.

> ORD ATIS INFO G 1556Z. 18011KT 10SM OVC200
> 29/21 A2986. ARR EXP VECTORS ILS RWY 14R
> APCH. ILS RWY 22R ARCH. LAND AND HOLD SHORT
> OPERATIONS ARE IN EFFECT. RWY 14R ARR PLAN
> TO H/S OF RWY 27L, 9 THSD 8 HND FT AVBL. DEPS
> EXP RWYS 22L, 27L. NOTAMS... RWY 18, 36
> CLSD, RWY 14L, 32R CLSD. TWY M CLSD BTN TW M4
> AND TW M6; TWY P CLSD BTN RWY 4L AND TWY P1;
> TWY V2 CLSD; TWY U CLSD; TWY M5 CLSD. PILOTS USE
> CTN FOR BIRD ACTIVITY IN THE VICINITY OF THE
> ARPT. WHEN READY TO TAXI CONTACT GND METERING ON
> FREQ 121.67. ...ADVS YOU HAVE INFO G.

The information “Golf” above for Chicago’s O’Hare International Airport (KORD) at 15:56 will improve the situational awareness in the flight deck once the message has been read, translated, and assimilated. Much of this information could also be presented to the crew as a graphical display overlay that utilizes an aerodrome mapping database and an interface to the digital ATIS receiver. Features of this graphical display could be specifically tailored to ATIS-type messages that are related to geographic information, for example:

- Active arrival and departure runways outlined or shaded uniquely
- Active “land and hold short” locations depicted
- Closed runway or taxiway segments can be uniquely depicted
- Areas of potential bird strikes can be uniquely depicted

A.7.2 Benefits

The display described above would primarily benefit flight crews by improving situational awareness with respect to the current aerodrome configuration, conditions, and recent NOTAMs. This approach would also reduce the likelihood of misreading the ATIS text or misunderstanding the recorded ATIS issued over the radio. Finally, if the system were designed to automatically receive and display the ATIS information, it is more likely that the crew would be aware of the most recent ATIS update.

It should be noted that a similar display resource could also benefit ATC (e.g., a graphical user interface could be used to generate ATIS information) and the operations facilities (e.g., a tool to aid in flight planning/scheduling as well as aircraft/vehicle servicing).

A.8 Aerodrome Surface Guidance and Navigation

A.8.1 Operational Concept

One of the anticipated applications of GNSS is aircraft navigation on the aerodrome surface. With the advent of GNSS augmentation systems[14], technology will soon be available to enable aircraft to obtain accurate position information while operating on the aerodrome

[14] Braff, R., “Description of the FAA’s Local Area Augmentation System (LAAS)”, Journal of the Institute of Navigation, Vol. 44, No. 4, pp. 411-423, Winter, 1997-1998.

surface. Standards are under development by both ICAO[2] and RTCA[4] in this area. Further, proposed Required Navigation Performance (RNP) requirements have been developed by NASA for surface movement[15]. Despite the capability of technology (i.e., GNSS) to perform the navigation function (i.e., determining position and velocity), there must be a means by which this position is relayed to the flight crew so that they can safely steer the aircraft from the current position to the desired destination. One approach is by presenting current position to the pilot relative to geographic locations stored in an aerodrome mapping database (see Figure A-4 through Figure A-12). These geographic references can be centerlines, runway/taxiway edges, painted markings, and/or obstructions. Using GNSS, an accurate database, and a display, the flight crew can determine, in real-time, both lateral and longitudinal track deviations (independent of visual aids).

In Figure A-4 through Figure A-12, the result of the navigation function is presented to the flight crew with respect to a virtual depiction of the runway/taxiway centerlines and/or edges. This approach is sometimes referred to as a form of *Synthetic Vision*. Figure A-4 through Figure A-10, and Figure A-12 use a head-down display device, while Figure A-11 uses a head-up display (HUD) device. The centerline and/or edge locations are stored in an aerodrome mapping database. These display concepts are the result of flight simulation and flight test research activities that have demonstrated an approach to low visibility aerodrome surface guidance/navigation using GNSS and an aerodrome mapping database[7, 10, 13].

Figure A-11 Aerodrome Surface Guidance/Navigation Using HUD

In most visibility conditions, surface navigation display functions, like the ones mentioned above, would be intended to supplement visual cues. Visual aids such as airfield signs, painted markings, and lights would continue to be used as the primary method of guidance/navigation. This supplemental information would be used by the crew as needed to reinforce any uncertainties associated with guidance presented by the visual aids (e.g., indeterminate sign direction arrows, missing centerline paint, etc.).

In extremely low visibility conditions or at aerodromes not equipped with sufficient visual aids, surface navigation displays (like the ones pictured) may be the primary, or sole,

[15] Cassell, R., Smith, A., and Hicok, D., "Development of Aerodrome Surface Required Navigation Performance (RNP)", NASA Contractor Report (CR-1999-209109), June, 1999.

means of guidance/navigation. Currently, for either of these cases, aerodrome operations cease; as there is no means of safe surface navigation.

Figure A-12 Head-Down Guidance/Navigation Display

A.8.2 Benefits

For pilots and vehicle operators, depiction of current position on a flight deck display (like the ones shown in Figure A-4 through Figure A-12), can result in operational benefits, particularly if current aircraft position is depicted graphically relative to geographic data. This function provides benefits similar to those provided by Navigation Displays (NDs) that are currently being used in the flight regimes. Access to this display during the surface operation (and prior to landing) can increase spatial awareness while decreasing uncertainties associated with available visual aids. This increased awareness can:

- reduce the likelihood of runway incursions and surface accidents
- reduce the likelihood of navigation errors on the surface
- enable higher roll-out, turn-off, and taxi speeds
- reduce the amount of radio communications required

Further, as weather conditions deteriorate, these benefits become more pronounced. In extremely low visibility conditions, this guidance/navigation tool can become an enabling technology. Despite the fact that autoland and HUD systems allow Category III-B landings, these operations are not permitted at VMC flow rates, in large part, because flight crews cannot safely navigate while moving on the aerodrome surface. A surface navigation function that supplements visual aids would be essential in enabling “0/0” flight operations as well as higher capacity IMC flow rates on the aerodrome surface.

A.9 Resource Management

A.9.1 Operational Concept

Commercial airlines, cargo airlines, and the Fixed Base Operators (FBO) who manage GA and business aviation operations, are responsible for many resources on and about the aerodrome vicinity. Examples of these resources include:

- Aircraft
- Service vehicles
- Maintenance hangars
- Simulation facilities
- Apron control operations facilities
- Operations control centers

An accurate, complete aerodrome GIS database, and an associated toolset, can be made available to airport operations control centers, apron control operations facilities, and maintenance facilities to improve operational efficiency. Further, efficiency models can be developed, using ad hoc analysis or real-time methods, that maximize procedural efficiencies associated with crew bus dispatch, aircraft/vehicle routing, and asset management.

A graphical depiction of aerodrome surface features, obstacles, and/or movement boundaries along with information on resource status/location can be combined in a GIS layered database that can be accessed by appropriate personnel. Networked terminals providing access to this database can be located based on the needs of a specific airline/FBO. In addition to aerodrome mapping information, this database can include the following types of information layers relevant to resource management:

1. Service facility information
2. General and business aviation maintenance areas
3. Asset identification, status, and inventory
4. Cargo maintenance areas
5. Parking/stand assignments and status
6. Airline maintenance
7. Apron route planning
8. Crew scheduling and dispatch information

An example is the Surface Movement System (SMS) that integrates airline schedules, stand information, flight plans, radar feeds, and runway configuration (departure splits and landing direction) to improve coordination and planning of the ground aerodrome traffic operation. The integrated information is then re-transmitted over the networked system and shared between the Air Traffic Control Supervisors, Aerodrome Managers/Operators, Air Traffic Controllers, Airline Operators, and Apron Operators at the aerodrome. For aerodrome mapping databases (AMDBs) to be of use to SMS, the following data elements are required: apron centerlines, apron edges, stand centerlines, stand locations, aircraft that a particular stand can handle, and stands associated with a particular apron. Accurate standardized AMDBs would allow SMS to be more easily configured, ported, and customized to any given aerodrome surface environment.

A.9.2 Benefits

A spatial aerodrome surface database and an associated toolset can support varied needs of Commercial/Cargo/GA/Business aviation operators. It addresses the need for a component-based system that can enable more efficient monitoring and movement of resources. These resources include: aircraft, service vehicles, equipment, and crew. Valuable commodities can also be more efficiently managed including passengers, baggage, and cargo. Tracking and identification of physical resources can also be managed using a GIS system and its associated database.

A.10 Training and High Fidelity Simulation

A.10.1 Operational Concept

Flight simulators are used in all phases of advanced flight training/education, including pilot type ratings and regularly scheduled mission rehearsals. Flight simulators are classified into four different quality levels (JAR-STD 1A): A, B, C, and D. All levels require a database (JAR-STD 1A, AMC STD1A.030 paragraph 2.3) that includes:

- General aerodrome outline
- All runways
- Glide slope transmitter position for all runways
- Position of the glide slope receivers for all runway
- Type of approach lighting system for all runways

In addition, level D certified visual systems (JAR-STD 1A, AMC STD1A.030 paragraph 2.3) require sufficient scene content to recognize:

- Aerodrome features
- Terrain with major terrain features
- Major landmarks around the aerodrome

Far beyond these requirements, state-of-the-art flight simulator databases also have:

- Taxiway outlines
- Taxiway markings
- Taxiway signs
- Apron markings
- Parking positions
- Aerodrome buildings
- Gates and jetways

Current training simulation systems only provide relative positions. With the introduction of new aviation procedures such as GNSS approaches, all simulation aerodrome databases will need to be geo-referenced to precise absolute three-dimensional positions. WGS84 geo-referencing is required to be GNSS compliant. The simulator integration of Terrain Awareness Warning Systems (TAWS) requires terrain and obstacle information in the vicinity of the aerodrome. For simulation purposes, precise aerodrome data is needed after integrating next-generation navigation displays with moving map taxi-guidance functionality.

For realistic training, all geo-spatial information stored within each individual aircraft system (e.g., TAWS, FMS, ND, etc.) will have to match the database stored in the simulator's visual database. The only common reference system that these distinct systems share is an absolute positioning system based on geo-coordinates.

A.10.2 Benefits

All simulator database vendors can use geo-referenced aerodrome databases as the basis for future simulator visual databases. Currently, they replace all available databases to make them compliant with geo-referenced GNSS approach procedure requirements. Cost can be significantly reduced by the availability of aerodrome databases. Even current geo-referenced databases used in simulators can be enriched with additional more precise geo-information.

Problems with an insufficient matching of moving map guidance displays and algorithms such as those employed by TAWS can be avoided if the databases used to generate visual scenes in simulators are consistent with (if not identical) to those used onboard aircraft.

A.11 Aerodrome Facility Management

A.11.1 Operational Concept

There are six primary categories of activities that come within the scope of aerodrome facility management:

- Planning
- Airfield design
- Facility design
- Construction
- Environmental
- Administration

Each of these activities can benefit from the availability of an aerodrome database. To ensure consistency across the applications a Geographic Information System (GIS) layered database structure with attribute data can be utilized. Every aerodrome implementation will be unique. It is anticipated that the primary depository for this database will be some form of an Aerodrome Operational Control Center (OCC). Secondary depositories, with full functionality, may be located at Maintenance Control Centers (MCCs), Aerodrome Engineering Centers (AECs), and Movement Area Control Centers (MACCs).

The current problem at most aerodromes is the establishment of “data islands” within each aerodrome organization. Consequently, the practice has been to develop databases for a specific need. The result has been duplicated databases with inconsistent key fields and an environment where no standards exist. Many aerodrome departments use incompatible vendor-specific formats that lead to inefficiencies and low performance, as well as high costs and low quality. Storing data in a GIS database structure can result in tremendous efficiencies being realized.

A.11.1.1 Planning

Capacity, land use, noise, and environmental management are all issues facing the aviation industry. The planning process is integral in developing and maintaining aerodromes and resolving issues relating to technical and legislative changes that impact upon the individual aerodrome and upon the industry as a whole. Planning databases may contain layered information that would be resident in an enterprise database schema.

A.11.1.2 Airfield Design

Heavier aircraft and increased operations are producing a strain on airfields worldwide. Aerodromes are quickly approaching capacity, while runway, taxiway and apron availability is becoming severely limited. Pavement at many aerodromes is far beyond its useful life and is failing. In addition, recent changes to airfield signage requirements have resulted in a need to install new signs at aerodromes. Aerodrome design database information must account for present and future needs. In order to meet these requirements, the data must be retrievable in such a way that it can be used by consultants, planners, and designers to develop three-dimensional simulations of the aerodrome. These simulations will allow multiple alternative schemes to be assessed before any one scheme is adopted.

A.11.1.3 Facility Design

Roadways, buildings, mechanical, electrical, and plumbing systems are special issues that arise when facilities are located on aerodromes. Facility design database information should include the requirements for safety, airspace restrictions, operational issues, noise abatement issues, environmental issues, and revenue-generation issues such as terminal space leasing to tenants.

A.11.1.4 Construction

Construction personnel, managers, and inspectors require specific information when operating in an aerodrome environment. Databases are required to understand individual airfield operations, government regulations, aerodrome safety requirements for construction, and coordination of construction activities.

Construction management services on aerodrome projects may require information on special phasing considerations to prevent operational interruptions. To reduce administrative burdens and related costs incurred by aerodromes and aerodrome planning boards, cooperation between planner, designer, contractor, construction manager, and the aerodrome administration are critical for both large and small projects.

A.11.1.5 Environmental

Virtually every aerodrome project has a critical need to identify and define environmental issues and solutions that provide for a realistic design and implementation plan. Issues of concern to aerodrome operators include performance of environmental evaluations of facilities, providing training for personnel, administering environmental programs, and developing environmental manuals.

A.11.1.6 Administrative

Aerodrome planning boards have requirements for familiarity with the policies, procedures, and internal structures of each aerodrome, and the sources that fund work to be performed at each aerodrome. To that end, each aerodrome must maintain close relationships with the national aviation authorities, and must have a thorough understanding of any plan to develop and expand aerodromes. The information maintained in databases assists the aerodrome staff to prepare development strategies for aerodrome improvements.

A.11.2 Benefits

The benefits for aerodrome facility management are categorized as:

- Reduced staff time for analysis
- Quick response to questions
- Ability to address complex issues
- Ability to provide better information to the decision makers
- Reduced cost to develop applications
- Creation of a basic framework to administer geospatial data

The use of consistent, standardized data results in the creation of an efficient data warehouse for the aerodrome organization. The data warehouse concept results in beneficial data management and analysis technology and techniques. The data are used to enhance the value of the aerodrome's data by replication, and it becomes more than just data, it becomes a set of tools. The initial creation of a data warehouse requires a commitment of resources. However, the payback to the aerodrome organization can be realized in multiple efficiencies.

Another benefit of such a database is the capability of data to retain its natural spatial information. For example, data can be visualized as in the real world and thus, can create a common language for the aerodrome organization to use. Also, spatial queries will serve to broaden the information that is available, and users will want to use the system because it is user-friendly and intuitive.

Some of the benefits of standard data are:

- Ease of processing and integrating data into various applications
- Longevity given to the data
- Assistance given in maintaining links to the legacy systems
- Ensured compatibility between systems
- Cooperation facilitated between database application developers
- Opening to additional external sources of data

A.12 Emergency and Security Services Management

A.12.1 Operational Concept

A critical need exists to integrate the system designs of the adverse weather navigation systems being developed for aerodromes. Systems are being developed for both aircraft and aerodrome ground vehicles (e.g., emergency and security vehicles). The problems and requirements related to central control and safe operation during simultaneous surface movement of a mixed vehicle fleet are broad in scope. Challenges exist under normal and emergency conditions that require all vehicles be controlled, monitored and managed by a single control function. All aerodrome surface vehicles (i.e., aircraft and vehicles) must use common guidance reference data having a specific accuracy to prevent potential problems that would be associated with uncoordinated activities during adverse weather conditions. It becomes essential that cost-effective and dependable methods and designs be developed that will ensure safe operation of a mixed fleet consisting of aircraft and ground vehicles when operated simultaneously during adverse weather conditions.

Driven by the need to respond quickly to accidents (or security breeches) that occur in poor visibility conditions, ground vehicles can be outfitted with equipment to improve response capabilities. The capabilities provided can enable the Aerodrome Rescue and Fire Fighting (ARFF) operations centers and the fire fighters themselves to more quickly locate a fire/crash sight during the times of adverse visibility (i.e., at night and/or during poor weather conditions). Security operations centers and the associated personnel and vehicles have similar needs when responding to a site where there is a potential security threat.

Using a Primary Base Station (PBS) located in an aerodrome Operations Communications Center (OCC), coordination and management of emergency and security services can be performed. These services include:

- Tracking vehicle location and identity
- Maintaining/distributing checklists and procedures
- Monitoring vehicle status
- Acquiring aircraft data
- Acquiring incident status data
- Acquiring hazardous material information
- Enabling/disabling alarm functions
- Dispatching emergency/security resource

The PBS display can be supported by a GIS map database of the aerodrome and surrounding area to include the Aerodrome Emergency Plan (AEP) area; typically a five mile radius from the end of each runway. Further, the map database can be layered with the option of displaying any combination of informational layers available to either the control center or the vehicle.

A.12.2 Benefits

Emergency and security vehicles outfitted with equipment and aerodrome surface databases as described will be able to respond even faster and with more situational awareness particularly in poor visibility conditions. OCCs will be able to work more efficiently to control and monitor movements to ensure conflict avoidance and rapid response. The use of common guidance information, having a high degree of integrity, can prevent potential problems that would be associated with uncoordinated activities during adverse weather conditions. Development of aerodrome surface databases used to support simultaneous surface movement of a mixed vehicle and aircraft fleets can increase safety margins and performance. Emergency and security operators using aerodrome databases and associated displays (Figure A-13) can also:

- Reduce operator workload
- Increase coordination/dispatch capabilities
- Enable clear, unambiguous communication of information
- Enable drivers to travel the most direct routes to a prescribed destination (e.g., fire location) quickly and safely regardless of visibility

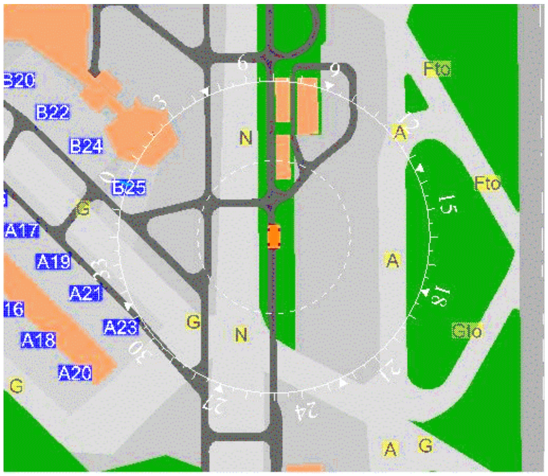

Figure A-13 Emergency/Security Vehicle Display

A.13 Runway Operations

A.13.1 Operational Concept

Using a robust position sensor (e.g., augmented GNSS), a display (either auditory or graphical), and an adequate aerodrome database, guidance can be provided in real-time to pilots so that they can effectively manage aircraft energy and location during takeoff and during landing roll-out and turn-off from the runway.

During take-off, access to sufficient runway information can allow a guidance profile to be generated based on conditions that may be changing dynamically. This guidance can be provided on either the PFD, ND, HUD, or any other available display in the flight deck. Further, important situational information could be provided such as where on the runway the aircraft is projected to reach specific V speeds and where the flight crew would need to consider a departure-abort. Finally, alerts could be generated to warn the pilot if there is insufficient runway remaining to either perform a departure-abort or to lift-off.

Similarly, during the last stages of landing (e.g., the flare) and during landing roll-out and runway exit, sufficient runway information could enable guidance profiles to be generated to aid the pilot's decision making in these critical stages. This guidance could be tailored to provide several functions:

- Warning if landing fast or long
- Guidance to optimal touchdown point
- Flare guidance
- Optimal guidance to desired exit
- Runway remaining guidance
- Warning of potential overrun
- Deceleration guidance to ensure passenger comfort and reduce brake wear

Finally, in conditions of low visibility or at night, this application could help the pilot ensure that he is maintaining an appropriate track, both laterally and longitudinally, during takeoff roll, landing roll-out, and normal taxi. In conditions of good visibility, this is done using visual references such as center lines/lights, runway edge lines/lights, and runway remaining signs. A aerodrome moving map could be used to prevent runway excursions, whereby the landing gear exists the runway or taxiway, leading to aircraft shutdown, and tow.

A great deal of research has been done involving these applications at various research centers. For example, NASA has developed a Takeoff Performance Monitoring System (TOPMS) and a Roll-out Turn-off (ROTO) guidance system. Both of these conceptual systems were designed to provide many of the functionalities described above.

A.13.2 Benefits

Potential benefits of this application for takeoffs include:

- Reduced number of departure-aborts
- Reduced likelihood of takeoff accidents
- Optimized aircraft performance during departure roll
- Improved fuel efficiency

Potential benefits of this application for arrivals include:

- Reduced number of overruns
- Reduced number of go-arounds
- Reduced/predictable roll-out times in any visibility or weather condition
- Reduced brake wear
- Optimized aircraft performance
- Fewer runway excursions

A.14 Notice to Airmen (NOTAM) and Aeronautical Data Overlays

A.14.1 Operational Concept

Aeronautical data overlays, including aerodrome NOTAMs, are one kind of advisory information that could be disseminated to flight crews using a Flight Information Services – Broadcast (FIS-B) data link system. FIS-B is an emerging data link concept (with several implementations underway) that is intended to provide weather and other flight advisory information to pilots in a way that will enhance their awareness of the flight situation and enable better strategic decision-making. The information provided through FIS-B will be advisory in nature, and is considered non-binding advice and information provided to assist in the safe conduct of a flight. With this information, pilots will be better able to assess potential hazards as well as make better decisions that will improve operational safety and efficiencyAt present when the weather deteriorates, voice radio calls from pilots to air traffic controllers or to flight service station specialists requesting FIS-B kinds of information become more necessary and more frequent. This clogs voice radio frequencies just when the demand for the data is the highest. It is envisioned that FIS digital broadcast data will be continuously received and stored to be readily available as needed or requested by the pilot.

Implementation of an FIS-B data link system is not intended to replace existing voice radio FIS services. Loss or non-receipt of FIS-B data link services would not be considered flight critical. In the initial implementation, it is anticipated that FIS-B data link services will be used primarily to supplement or complement established sources of weather and operational information, including receipt of an integrated aeronautical information package prior to departure. Existing sources such as the Flight Service Station network, ATC facilities, and/or the corporate/airline dispatchers, would still be available to provide timely data In the end state, FIS-B services will assist both individual pilot and collaborative decision making (CDM) processes.

As envisioned, graphical or other display of NOTAM information can be facilitated by the Aerodrome Mapping Database (AMDB). A comprehensive AMDB will include all the required "raw materials" for depiction of graphical NOTAMs, such as runways, taxiways, and aerodrome structures. The NOTAM and aeronautical data overlay concept is an operational concept as to how graphical NOTAMs/aeronautical data could work with the AMDB. In the envisioned application, the graphical display of the data can be described as overlay graphics referenced to and correlated with AMDB objects. For example, a runway closure could be depicted as a graphical overlay of the runway object stored in the AMDB. An example is given below.

A.14.2 Benefits

The anticipated benefits of this concept are as follows:

- Better and more efficiently communicated information
- "One-stop" shopping for information
- Enhanced situational awareness
- Less reliance on today's dispatch release form
- Less concern that inaccurate, incomplete, or out-dated information was being made available
- En route updates would be updated by FIS data link, and provided as textual and as graphical overlay products
- Near instantaneous dissemination of SUA and aerodrome-related NOTAM's and related information
- Reduced communications costs because of use of a public use, not dedicated, land line system
- Less data entry delay because other parties other than the source originator would be eliminated from the process of data entry and verification. The originator would enter time-perishable data directly into the system, with little if any delays

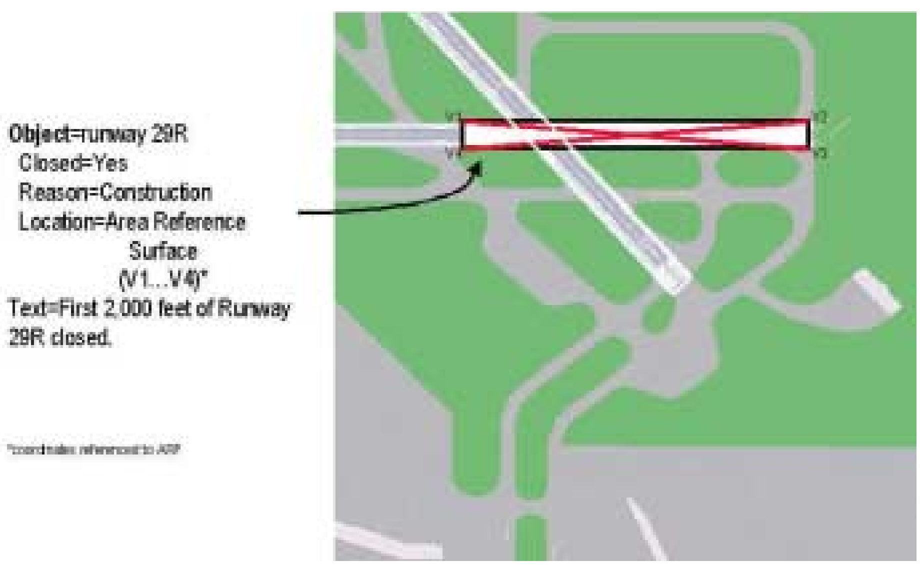

Figure A-14 NOTAM Graphical Overlay Denoting Portion of Runway Closed

NOTAM	Attribute Specification
Closed Runways	Object name (runway), closed, reason, surface referencing polygon
Closed Taxiways	Object name (taxiway), closed, reason, surface referencing polygon
Designated construction areas	Object name, reason, surface bounding polygon, hours of construction activity
Temporary grass cutting, snow plowing operations, agricultural activity/areas	Object name, closed, reason, surface referencing polygon, time started, time ended
Clutter/contamination on specified runways and taxiways	Object name, reason, amount, surface bounding polygon
Lighting equipage and status (VASI, PAPI, ALSF-2, etc)	Object name (light), location, status
Signage (e. g., missing, blown-over, obscured, etc)	Object name (signage), location, status
Runway and taxiway markings (e.g., worn, missing, snow covered, etc)	Object name (runway), surface type, surface condition, paint, status, surface referencing polygon
Areas of low-braking effectiveness	Object name(designated area on apron)), special comments, referencing polygon
Engine maintenance run-up areas and heading alignments	Object name (designated area on aerodrome), heading alignment required, special comments, referencing polygon
Location of FBOs on aerodrome with available parking highlighted (general aviation parking/refueling areas)	Object name (surface non movement area), special comments, surface referencing polygon
Designated customs clearing parking areas	Object name (designated surface non movement area), special comments (e.g., hours of operation; alternative parking area after hours), surface referencing polygon
Communication frequencies	Object (active aerodrome surface communication frequencies), description, referencing polygon
Gate/apron closures	Object name (gate/apron), closed, reason, surface referencing polygon

A.15 Aerodrome Asset Management: Managing Constraints on the Aerodrome Surface Using Hand-held Computers

A.15.1 Operation Concept

In today’s busy aerodrome environment, aircraft frequently arrive at an aerodrome only to find that they must wait for an available gate or, wait for a ramp agent to reposition the ramp-way to the aircraft. Additionally, service vehicles (such as refueling trucks), often spend extra time searching for parked aircraft, especially at night, often without any mechanical or electronic means to assist them.

At very busy aerodromes, surface movement delays often produce ripple effects that extend well beyond the ramp area and into the aerodrome surface movement. For instance, surface and “push-back” delays directly affect departure timing. Oceanic flight “slot times” at track entry fixes are very sensitive to these delays. Missing a departure slot can easily delay the takeoff of a flight for several hours.

Sometimes delays can affect safety. For example, sequencing to de-icing areas, and subsequent “hold-over” times prior to take-off, are all subject to critical timing and scheduling to minimize delay. It is in this operational context that airline, aerodrome staffs, and air traffic managers must also have a common, shared, situational awareness.

In the following concept of operations, appropriate personnel would be equipped with a small hand-held computer device. Each computer would have a flash card for wireless communication via TCP/IP with a local, Intranet-based, aerodrome information system. Each computer would also have a small database that would contain aerodrome slot information, and would receive on-line flight plan data from ICAO FPL, DEP, DLA, CNL and CNG messages, as well as actual data from departure and arrival MVT or ACARS messages. A simple installed software application would convert flight plan information into intuitive graphics. This software would create and position special color-coded icons on the display (see Figure A-15). These depictions would be displayed in a time-line based manner.

In the depiction, below, the “beginning” and “end” of the orange shape represent the arrival and departure aerodrome slot times. The dark blue shapes depict the estimated out, off, on, and in times (i.e., off-block, take-off, landing and in-block times) as well as the estimated turn-around times between two flight segments. The green shapes would be resized depending on the actual times while the vertical magenta line would show the current local time. ADS-B and TIS-B data would provide this information, including providing accurate surface movement predictions. Differences between the assigned aerodrome slots and the planned/actual times would also be graphically depicted. The user could zoom the map, and scroll the picture for better visualization of a specific aircraft or vehicle. The aircraft’s identification and current position would be depicted and, electronically transferred (by use of ADS-B or other data link) to the aerodrome information system, which would then re-broadcast it.

Each computer would have a GPS flash card, allowing aerodrome management to know where all surface vehicles are, assuming that there is GPS line-of-sight coverage.

A GSM flash card could provide each device with access to the local aerodrome map data base or to other aerodrome information systems. This same concept could include aerodrome refueling, baggage, and servicing vehicles. Graphical ATIS and graphical NOTAM “overlay” information could also be displayed on these small screens to assist ground personnel.

These devices would be equipped with tactile displays. Ramp agents and others could then use these input devices to enter “operational events” (such as the beginning and end of servicing) by simply touching the buttons on the screen with a stylus or finger.

Figure A-15 Example of a Hand-held Computer Using Aerodrome Mapping Data[16]

A.15.2 Benefits

This application could reduce surface movement delays, thereby enhancing airline and facility operational efficiency. Collectively, these applications would assist airline employees in better synchronizing work tasks with aircraft arrival and departure schedules. Dispatchers and ramp controllers would know the precise location of all aircraft and their status. Gate agents would know exactly when an aircraft would arrive at a stand/gate. Refuelling vehicles, service vehicles, and emergency response vehicles could easily locate a specific aircraft (especially if it was remote parked).

A.16 Synthetic Vision

A.16.1 Operational Concept

An aircraft's ability to conduct flight operations at aerodromes is dependent upon a number of factors. Among these, reduced visibility is a significant factor. As weather and visibility conditions deteriorate, it is increasingly difficult to conduct flight operations in the same manner and at the same rate as in visual metrological conditions. While today's technology provides solutions to many of the problems caused by low visibility, the potential now exists to provide information well beyond what the pilot is able to see even on a clear day. The operational concept is to create a *virtual visual environment* that all but eliminates reduced visibility as a significant factor in flight operations, and enhancing what the pilot can see even in the best of visibility conditions[17]. A virtual visual environment can be described in terms of its components and the operational flight phases it supports.

With respect to aerodrome operations, the synthetic vision "virtual visual environment" is composed of three components: an enhanced intuitive view of the aerodrome environment, conflict detection and display, and precision navigation guidance. The intuitive view is derived from an aerodrome mapping database with multi-system information superimposed or overlayed. This information is comprised of tactical information typically found on a primary flight display as well as strategic information typically found on a navigation display. Since cluttered displays are undesirable, pilots will need the ability to choose cer-

[16] Photo provided by EUROCONTROL.

[17] Williams, Dan, et al, "Concept of Operations for Commercial and Business Aircraft Synthetic Vision Systems", Version 1.0, January 2001, NASA Langley Research Center.

tain features so that the system and its displays will be able to present an intuitive and simple-to-comprehend visual depiction.

Many of the applications already listed in this appendix have already been demonstrated in the operational environment using synthetic vision technology including:

- Surveillance and conflict (runway incursion) detection and alerting
- Route and hold-short depiction and deviation detection and alerting
- Depiction of digital ATIS information
- Aerodrome surface guidance/navigation
- Runway operations

The reader is referred to the sections of this appendix that describe these applications in greater detail for sample synthetic vision display formats.

A.16.2 Benefits

Current technology systems allow flight crews to perform “all-visibility” en route flight operations as well as low-visibility approaches and landings to appropriately equipped runways. Synthetic vision systems have the potential to go beyond this present capability, and to extend it to also include all-weather surface operations. Such an expanded capability will enhance safety and provide operational benefits. Some synthetic vision systems are expected to emulate day visual flight operations at night and in limited visibility conditions. Others will provide visual cues commensurate with a ego-centered VMC view from the cockpit. Using synthetic vision systems, the overall accident rate and hull loss rate is expected to become that of day visual flight operations. Some of the expected safety benefits with respect to aerodrome operations include: runway incursion risk reduction, improved pilot situational awareness, improved non-normal situation response, and improved compliance with air traffic clearances and instructions. Potential capacity and efficiency benefits have also been identified including: reduced arrival and departure minimums, inclusion of additional multi-runway operations, and greater aerodrome access.

Appendix B

GLOSSARY

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Appendix B—GLOSSARY

Accuracy
A degree of conformance between the estimated or measured value and the true value. Note: for measured positional data, the accuracy is normally expressed in terms of a distance from a stated position within which there is a defined confidence of the true position falling. [ICAO Annex 14] Note: relative accuracy is defined with reference to a geodetic datum.

Aerodrome (Airport)
A defined area on land or water (including any buildings, installations, and equipment) intended to be used either wholly or in part for the arrival, departure, and surface movement of aircraft. [ICAO Annex 14]

Aircraft Stand
A designated area on an apron intended to be used for parking an aircraft. [ICAO Annex 14]

Aerodrome Elevation
The elevation of the highest point of the landing area. [ICAO Annex 14]

Aeronautical Data
Data used for aeronautical applications such as navigation, flight planning, flight simulators, terrain awareness, and other purposes, which comprises navigation data, terrain, and obstacle data. [DO-200A/ED-76]

Aeronautical Database
Any data that is stored electronically in a system that supports airborne or ground based aeronautical applications. An Aeronautical Database may be updated at regular intervals. [DO-200A/ED-76]

Aeronautical Data Preparation Agency
An agency, public or private, other than an originator and/or publisher of government source documents, who compiles official government document information into charts or electronic formats for computer-based systems. [DO-201A/ED-77]

Aeronautical Information Publication (AIP)
A publication issued by or with the authority of a State and containing aeronautical information of a lasting character essential to air navigation. [ICAO Annex 15]

Aeronautical Information Regulation and Control (AIRAC)
A regulated system aimed at advanced notification based on common effective dates of circumstances that necessitate significant changes in operating practices. [ICAO Annex 15]

Aerodrome Reference Point (ARP)
The designated geographical location of an aerodrome. [ICAO Annex 4]

Aerodrome Surface Movement Area
That part of an aerodrome (aerodrome) that is to be used for the take-off, landing, and taxiing of aircraft. This includes runways, taxiways, and apron areas.

AIRAC
The acronym (aeronautical information regulation and control) signifying a system aimed at advance notification based on common effective dates, of circumstances that necessitate significant changes in operating practices. [ICAO Annex 15]

Altitude
The vertical distance of a level, a point, or an object considered as a point, measured from mean sea level (MSL). [ICAO Annex 4]

Approved Source
An approved source is:

- a State which provides aerodrome mapping data with sufficient information so that the end-user can check that those data are suitable for its own application.
- a supplier accredited against this standard and the DO-200A/ED-76 by an appropriate organization.

Apron
A defined area, on a land aerodrome, intended to accommodate aircraft for purposes of loading or unloading passengers, mail or cargo, fuelling, parking, or maintenance. [ICAO Annex 14]

Assemble (Merge)
A process of merging aeronautical information from multiple sources into a database and establishing a baseline for subsequent processing. The assemble phase includes checking the data and ensuring that detected errors and omissions are rectified. [ICAO Annex 15]

Blunder Errors
From the statistical point of view, blunders or mistakes are observations that cannot be considered as belonging to the same sample from the distribution in question. They should not be used with other observations. They should be located and eliminated.

Clearway
A defined rectangular area on the ground or water under the control of the appropriate authority, selected or prepared as a suitable area over which an aeroplane may make a portion of its initial climb to a specified height. [ICAO Annex 4]

Completeness
The primary quality parameter describing the degree of conformance of a subset of data compared to its nominal ground with respect to the presence of objects, associations instances, and property instances.

Confidence
Meta-quality element describing the correctness of quality information.

Confidence Level
The probability that the true value of a parameter is within a certain interval around the estimate of its value. The interval is usually referred to as the accuracy of the estimate.

Correct Data
Data meeting stated quality requirements. [DO-201A/ED-77]

Corruption
A change to previously correct data introduced during processing, storage or transmission, that causes the data to no longer be correct. [DO-200A/ED-76]

Cyclic Redundancy Check (CRC)
A mathematical algorithm applied to a digital expression of data that provides a level of assurance against loss or alteration of data. [ICAO Annex 15]

Database
One or more files of data so structured that appropriate applications may draw from the files and update them. This primarily refers to data stored electronically and accessed by computer rather than in files of physical records. [ICAO Annex 15]

Data Quality
A degree or level of confidence that the data provided meets the requirements of the data user in terms of accuracy, resolution and integrity. [ICAO Annex 15]

Datum
A point, line, surface, or set of values used as a reference. A geodetic datum is a set of constants specifying the coordinate system and reference used for geodetic control (i.e. for calculating coordinates of points on the earth). At least eight constants are needed to form a complete datum: three to specify the location of the origin of the coordinate system; three to specify the orientation of the coordinate system; and two to specify the dimensions of the reference ellipsoid. [FAA doc. 405]

Deficiency
The aeronautical data process is not adequate to ensure that data quality requirements are satisfied. [DO-200A/ED-76]

De-icing Pad
An area comprising an inner area for the parking of an aeroplane to receive de-icing treatment and an outer area for the manoeuvring of two or more mobile de-icing equipment. [ICAO Annex 14]

Displaced Threshold
A threshold not located at the extremity of a runway. [ICAO Annex 14]

Distribution (Paper)
The process of disseminating documents containing formatted aeronautical data in various media, including the shipping and loading of a database into the target system for application. [DO-201A/ED-77]

Distribution (Data)
The process of duplication of formatted aeronautical data into a database and the shipping and loading of the database into the target system for application. Distribution is usually achieved by transferring the data from one medium to another, with each transfer being verified. [DO-200A/ED-76]

Elevation
The vertical distance of a point or a level, on or affixed to the surface of the earth, measured from mean sea level (MSL). [ICAO Annex 4]

Ellipsoid Height (Geodetic Height)
The height related to the reference ellipsoid, measured along the ellipsoidal outer normal through the point in question. [ICAO Annex 14]

End User
See User.

Enterprise Data
Common data used by multiple users but stored at a single location.

Format
The process of translating, arranging, packing and compressing a selected set of data for distribution to a specific target system. [DO-200A/ED-76]

Geodetic Datum
A minimum set of parameters required to define location and orientation of the local reference system with respect to the global reference system/frame. [ICAO Annex 14]

Geodetic Distance
The shortest distance between any two points on a mathematically defined ellipsoidal surface. [ICAO Annex 15]

Geographic Coordinates
The quantities of latitude, longitude which define the position of a point on the surface of the Earth with respect to a reference ellipsoid.

Geoid
The equipotential surface in the gravity field of the Earth which coincides with the undisturbed mean sea level (MSL) extended continuously through the continents. Note: the geoïd is irregular in shape because of local gravitational disturbances (wind tides, salinity, current, etc.) and the direction of gravity is perpendicular to the geoid at every point. [ICAO Annex 14]

Geoid Undulation (Geoid Height)
The distance of the geoïd above (positive) or below (negative) the mathematical reference ellipsoid. Note: with respect to the WGS-84 defined ellipsoid, the difference between the WGS-84 ellipsoidal height and orthometric height represents WGS-84 geoïd undulation. [ICAO Annex 14]

Global Navigation Satellite System (GNSS)
The GNSS is a world-wide position and time determination system, that includes one or more satellite constellations, aircraft receivers, and system integrity monitoring, augmented as necessary to support the required navigation performance for the actual phase of operation. [ICAO Doc 9524]

Helipad
A small designated area, usually with a prepared surface, on a heliport, aerodrome, landing/takeoff area, apron area, or movement area used for takeoff, landing, or parking of helicopters. [FAA doc. 405]

Heliport
An aerodrome or a defined area on a structure intended to be used wholly or in part for the arrival, departure and surface movement of helicopters. [ICAO Annex 14]

Imagery
The product of photography or advanced imaging sensors. Can be produced via either aerial or satellite flyovers.

Integrity of Aeronautical Data
A degree of assurance that an aeronautical data and its value has not been lost or altered since the data origination or authorized amendment. [ICAO Annex 14]

Maneuvering Area
That part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, excluding aprons.

Marking
A symbol or group of symbols displayed on the surface of the movement area in order to convey aeronautical information.

Mean Sea Level (MSL)
The average location of the interface between the ocean and the atmosphere, over a period of time sufficiently long so that all random and periodic variations of short duration average to zero. [FAA doc. 405]

Meta-Data
Information that describes or characterizes a collection of data (or a single data element).

Movement Area
That part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, consisting of the manoeuvring area and the apron(s).

Notice to Airmen (NOTAM)
A notice distributed by means of telecommunication containing information concerning the establishment, condition, or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations. [ICAO Annex 15]

Obstacle
All fixed (whether temporary or permanent) and mobile objects, or parts thereof, that are located on an area intended for the surface movement of aircraft or that extend above a defined surface intended to protect aircraft in flight. [ICAO Annex 14]

Obstruction
Any object that penetrates an obstruction identification surface. Note that this is considered to be a subset of the "Obstacle" definition, Note (2) please refer to section 6.3 for a discussion of Special Cases. [FAA doc. 405]

Obstruction Identification Surface
Any imaginary surface authorized by the FAA to identify obstructions. [FAA doc. 405]

Originator (Data)
The first organization in the aeronautical data chain that accepts responsibility for the data. For example, a State or DO-200A/ED-76-compliant organization. [DO-200A/ED-76]

Orthometric Height (or Elevation)
Height of a point related to the geoid, generally presented as an MSL elevation. [ICAO Annex 14]

Pavement Classification Number (PCN)
A number expressing the bearing strength of a pavement for unrestricted operations. [ICAO Annex 14]

Position (Geographical)
Set of coordinates (latitude, longitude) referenced to the mathematical reference ellipsoid which define the position of a point on the surface of the Earth. [ICAO Annex 15]

Precision
The smallest difference that can be reliably distinguished by a measurement process. Note: in reference to geodetic surveys, precision is a degree of refinement in performance of an operation or a degree of perfection in the instruments and methods used when making measurements. [ICAO Annex 15]

Quality
Totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs. Note: entity is an element which can be individually described and considered. (ISO 8402) [ICAO Annex 15]

Quality Assurance
All the planned and systematic activities implemented within the quality system, and demonstrated as needed, to provide adequate confidence that an entity will fulfill requirements for quality. (ISO 8402) [ICAO Annex 15]

Radiometric Resolution
The capability of a sensor to discriminate levels or intensity of spectral radiance. In the analogue systems such as photography, the radiometric resolution is measured based on the number of gray levels that can be obtained. In opto-electronic systems, the radiance is recorded in an array of cells. A digit is assigned to each cell proportional to the received level of energy. This is done by an analog to digital converter in the platform. Generally, in modern sensors the range is between zero radiance into the sensor and 255 at saturation response of the detector.

Ramp
See Apron.

Random Errors
Random errors of observations refer to the basic inherent property that estimates of a random variable do not agree, in general, with its expectation.

Reference Ellipsoid
A geometric figure comprising one component of a geodetic datum, usually determined by rotating an ellipse about its shorter (polar) axis, and used as a surface of reference for geodetic surveys. The reference ellipsoid closely approximates the dimensions of the geoid, with certain ellipsoids fitting the geoid more closely for various areas of the earth. Elevations derived directly from satellite observations are relative to the ellipsoid and are called ellipsoid heights. [FAA doc. 405]

Repeatability
The level to which a measurement, when repeated, will agree with the previous value. The consistency of results provides a measure of the degree of repeatability, though not necessarily its accuracy. In determining the consistency, the precision of the repeated measurements are taken into account). [DO-201A/ED-77]

Resolution
A number of units or digits to which a measured or calculated value is expressed and used. [ICAO Annex 15]

Runway
A defined rectangular area on a land aerodrome prepared for the landing and take-off of aircraft. [ICAO Annex 14]

Runway-holding Position
A designed position intended to protect a runway, an obstacle limitation surface, or an ILS/MLS critical/sensitive area at which taxiing aircraft and vehicles shall stop and hold, unless otherwise authorized by the aerodrome control tower. [ICAO Annex 14]

Runway End Safety Area (RESA)
An area symmetrical about the extended runway centerline and adjacent to the end of the strip primarily intended to reduce the risk of damage to an aeroplane undershooting or overrunning the runway. [ICAO Annex 14]

Situational Awareness
The perception of elements in the environment, the comprehension of their meaning, and the projection of their status into the near future. [Endsley, 1990] For example, for pilots, the elements of the environment include, but are not limited to, the crew, passengers, aircraft systems, time, position, weather, traffic, and ATC constraints.

Spatial resolution
The capacity of the system (lens, sensor, emulsion, electronic components, etc.) to define the smallest possible object in the image. Historically, this has been measured as the number of lines pair per millimeter that can be resolved in a photograph of a bar chart. This is the so-called Analogue Resolution. For the modern photogrammetric cameras equipped with Forward Motion Compensation (FMC) devices and photogrammetric Panchromatic Black and White emulsions, the resolution could (depending on contrast) be 40 to 80 lp/mm (line pairs per millimeter).

Seaplane Landing Area (SLA)
A defined area on water at an aerodrome prescribed for the landing and takeoff of seaplanes.

Seaplane Landing Lane (SLL)
A defined path on water at an aerodrome prescribed for the landing and takeoff run of seaplanes along its entire length.

Shoulder
An area adjacent to the edge of a pavement so prepared as to provide a transition between the pavement and the adjacent surface.

Spectral resolution
The capability of a sensor to discriminate the detected radiance in different intervals of wavelengths of the electromagnetic spectrum. Hence, the spectral resolution is determined by the number of bands that a particular sensor is capable to capture and by the corresponding spectral bandwidth.

Stand
See Aircraft Stand.

State
A term referring to an internationally recognized geographic entity which provides Aeronautical Information Service. [ICAO Doc 7300]

Stopway
A defined rectangular area on the ground at the end of take-off run available prepared as a suitable area in which an aircraft can be stopped in the case of an abondoned take-off. [ICAO Annex 4]

Systematic Errors
These are systematic effects. These effects can be minimized via instrument calibration and/or the use of the appropriate math model. However, from the statistical point of view, they will affect all the repeated observations in the same way. These errors cannot be discovered by repetition of observations.

Taxi-holding Position
A designated position at which taxiing aircraft and vehicles shall stop and hold position, unless otherwise authorized by the aerodrome control tower. [ICAO Annex 4]

Taxiway
A defined path on a land aerodrome established for the taxiing of aircraft and intended to provide a link between one part of the aerodrome and another, including:

a. *Aircraft stand taxilane.* A portion of an apron designed as a taxiway and intended to provide access to aircraft stands only.
b. *Apron taxiway.* A portion of a taxiway system located on an apron and intended to provide a through taxiway route across the apron.
c. *Rapid exit taxiway.* A taxiway connected to a runway at an acute angle and designed to allow landing aeroplanes to turn off at higher speeds than are achieved on other exit taxiways thereby minimizing runway occupancy times.

Taxiway Intersection
A junction of two or more taxiways.

Temporal Resolution
The periodicity through which a sensor can acquire a new image of the same spot of the earth’s surface. This depends on the altitude of the orbit and on the aperture angle of observation.

Terrain
Natural surface of the earth excluding man-made obstacles. [DO-200A/ED-76]

Threshold
The beginning of that portion of the runway that is available for landing. [ICAO Annex 14]

Touchdown Zone (TDZ)
The portion of a runway, beyond the threshold, where it is intended landing aeroplanes first contact the runway. [ICAO Annex 4]

Traceability
Ability to trace the history, application or location of an entity by means of recorded identifications. (ISO 8402) [ICAO Annex 15]

User of Aeronautical Data
The group or organization using the system that contains the delivered aeronautical data on an operational basis, such as the airline operator. (Note, the user may also be referred to as the "end user.") [DO-201A/ED-77]

Validation
Confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled. (ISO 8402) [ICAO Annex 15]

Verification
Confirmation by examination and provision of objective evidence that specified requirements have been fulfilled. Objective evidence is information which can be proved true, based on facts obtained through observation, measurement, test or other means. (ISO8402) [ICAO Annex 15]

The activity whereby the value currently accorded to a data element is checked against the value originally supplied. [DO-200A/ED-76]

Vertical Object
An object with vertical extent that is within the designated buffer area.

Appendix C

ABBREVATIONS AND ACRONYMS

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Appendix C—ABBREVATIONS AND ACRONYMS

ADS-B	Automatic Dependent Surveillance - Broadcast
AIP	Aeronautical Information Publication
AIRAC	Aeronautical Information Regulation and Control
AIS	Aeronautical Information Service
AIXM	Aeronautical Information Exchange Model
ALP	Airport Layout Plan
ALSF-2	High Intensity Approach Lighting with Sequenced Flashing Lights
AMDB	Aerodrome Mapping Database
ARINC	Aeronautical Radio Incorporated
ARP	Aerodrome Reference Point
A-SMGCS	Advanced Surface Movement Guidance and Control System
ATC	Air Traffic Control
BITE	Built-in Test Equipment
CAA	Civil Aviation Authority
CAD	Computer-Aided Design
CFIT	Controlled Flight Into Terrain
ETRF	European Terrestrial Reference Frame
EUROCAE	European Organisation for Civil Aviation Equipment
FAA	Federal Aviation Administration
FAR	FAA Aviation Regulation
FATO	Final Approach and Takeoff areas
FHA	Functional Hazards Assessment
GIS	Geographical Information System
GNSS	Global Navigation Satellite System
ICAO	International Civil Aviation Organization
ILS	Instrument Landing System
INS	Inertial Navigation System
JAA	Joint Aviation Authority
LAAS	Local Area Augmentation System
LAHSO	Land and Hold Short Operation
MSL	Mean Sea Level
NOTAM	Notice to Airmen
NA	Not Applicable
NM	Nautical mile
OIS	Obstruction Identification Surface
PANS-OPS	Procedures for Air Navigation Services and Operations
PCN	Pavement Classification Number
PDF	Probability Density Function
RNP	Required Navigation Performance
RTCA	Requirements and Technical Concepts for Aviation
SA	Situational Awareness
SAE	Society of Automotive Engineers
SARPS	ICAO Standards and Recommended Practices
TIN	Triangular Irregular Network

TIS-B	Traffic Information Service - Broadcast
TLOF	Touchdown Liftoff areas
UDDF	Universal Data Distribution Format
WGS84	World Geodetic System 1984

Appendix D

AERODROME MAPPING DATA CONSIDERATIONS

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Appendix D—AERODROME MAPPING DATA CONSIDERATIONS

D.1 Reference System Considerations

Due to aerial navigation considerations and the state of the art regarding the use of the Global Positioning System (GPS) for instantaneous positioning and navigation, the Reference Frame of the AMDB shall be based on the theoretical surface and universally positioned ellipsoid, WGS-84.

In all those cases where an aerodrome map or database already exists and it is based on a different reference system, shall be transformed to the WGS-84 environment. In this sense the user may choose different approaches, among them the use of the *Unabridged Modelenskii Series* or the *Rigorous Solution* that is based on a seven-parameter three-dimensional transformation. This contemplates three shifts of the center of the old to the new ellipsoid, three rotations or attitude of the old to the new ellipsoid and one scale factor relating possible local deformations of the old system.

If the user decides to apply the *Rigorous Solution* this should contemplate the local geoid undulations during the computations of the Cartesian coordinate system.

D.2 Errors

Modern information theory regards the observations as signals, the statistical properties of which are classified as having deterministic and stochastic components. This philosophy regards errors as properties of observations. Nevertheless, the classical theory considers errors as being of three types, namely: *Random Errors, Systematic Errors and Blunders*.

D.3 Random Errors

When talking of observational errors or random errors of observations, we refer to the basic inherent property that estimates of a random variable x do not agree, in general, with its expectation. Thus an observational error may in this context be defined as:

$v_I = x_I - \mu_x$,

with x_I= estimate I of the random variable x

μ_x= *population mean. (also for sample mean).*

D.4 Systematic Errors

The effects of systematic errors can be minimized via instrument calibration and/or the use of an appropriate mathematical model. From the statistical point of view it should be noted that *Systematic Errors* will affect all repeated observations in the same way. So they cannot be discovered by repetition of observations. An elimination of systematic errors can only be accomplished by the use of the appropriate mathematical model. Thus a triangle on the Earth's surface may be treated by one of the three functional models: plane, spherical, or ellipsoidal. The choice of one over the others will result in different values of systematic errors.

D.5 Blunders

From the statistical point of view blunders, or mistakes, are observations that cannot be considered as belonging to the same sample from the distribution in question. Therefore they should not be used with other observations, and should be located and eliminated. In the advanced surveying practice statistical procedures, digital filters, etc. exist that are capable of locating and eliminating these errors.

D.6 Error Assessment

With regard to the treatment to be given to the above types of errors during aerodrome data acquisition for AMDB generation purposes, statistical methods should be applied in order to assess the random errors.

Digital filters based on statistical principles should be designed in order to locate and eliminate blunders. The surveying sciences have developed highly effective techniques for this purpose. Statistical test based on a corresponding probability density function of the measured or derived statistic, pre-adjustment data-snooping strategies, and simultaneous adjustment with robust estimators are advised for this purpose.

With regard to systematic errors, deterministic procedures should be adopted to correct the observations or they should be taken into consideration in the derived statistics. Each data acquisition method or data to be acquired has its own systematic effect or bias included in the value of the statistics themselves. To eliminate systematic errors, there are two main approaches:

1. use of the appropriate mathematical model that describes the systematic effect (e.g., Earth curvature, refraction, etc.);
2. use of extended functional models to account for a combination of systematic effects of known sources and quasi-random effects that are difficult to model. A typical case is the auto-calibration (or additional parameters) used in Photogrammetric Aero-Triangulation.

Either approach should be followed as necessary and according to the method and statistics involved.

D.7 Confidence Level of a Database

There are mainly two methods of estimation that hold four important criteria *consistent, unbiased, efficient* and *sufficient*. They are the method of Maximum Likelihood and the method of Least Squares. The Maximum Likelihood method requires knowledge of the distribution from which the observations come for the purpose of parameter estimation. On the other hand, the method of Maximum Likelihood is more laborious from the computational point of view. In the case of normal distributions, the *Method of Least Squares* will give identical results to those of the *Method of Maximum Likelihood*.

With linear functions, the estimated parameters (in particular the estimated expectations) are consistent, unbiased, efficient, sufficient, and have the minimum variance property, especially when there is not systematic effects in the observations. Due to all above reasons, the method of Least Squares is recommended as the estimation method to use during all survey operations leading to an AMDB.

The estimation of means, variance and covariance of random variables from sample data is referred to as *point estimation*, because it results in one value for each parameter in question. By contrast to point estimation, establishing confidence interval from sampling is referred to as *interval estimation.* After having performed a point estimation – for instance, having estimated the coordinates of one point – the question remains:

How good is my estimation and how much can be relied on?

A simple answer is not possible because sampling never leads to the true theoretical distribution or its parameters. It is only possible to estimate probabilities with which the true value of the parameter in question is likely to be within a certain interval around the estimate. Such probability can be determined if we know the distribution function f(x) of the random variable

$$P(x_1 < x < x_2) = \int_{x1}^{x2} f(x)dx$$

By analogy, the probability statement for a confidence interval of the parameter s can be expressed as

$$P(s_1 < s < s_2) = 1 - \alpha$$

where $(1 - \alpha)$ is called the Confidence Level, conventionally taken to be 90%, 95%, or 99%.

The values s_1 and s_2 are the lower and the upper confidence limits for the parameter s. The above equation defines the confidence interval for the parameters as the interval around the estimate s, such that the probability that this interval includes the (unknown) true value of the parameter is $(1-\alpha)$. The probability that the true value of the parameter does not fall in a given interval is the value α. The width of the confidence interval decreases as the degree of freedom increases and as the level of probability associated with it decreases.

Based on the above definitions we can conclude that the confidence level of a geospatial database is directly related with the lowest confidence level of existing random variables in the database.

From the statistical point of view any sort of error will affect the confidence level of the database, with a greater emphasis on the systematic and blunder errors. Methods to use to locate and eliminate these two types of errors have been outlined above.

D.8 Accuracy and Precision

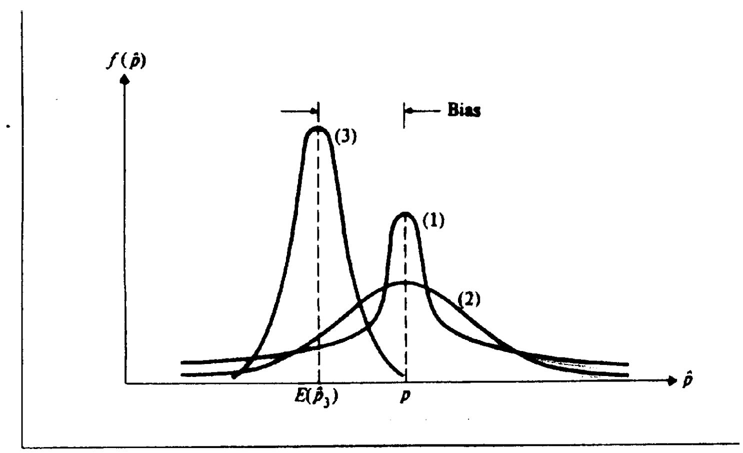

Figure D-1 Probability Distribution Functions

Precision may be defined as the degree of conformity among a set of observations of the same random variable. The spread (or dispersion) of the probability distribution is an indication of the precision. Therefore in the figure above (2) is least precise and (3) is most precise.

Accuracy may be defined as the extent to which an estimate approaches its parameter (in conventional terms, it is considered as the degree of closeness to the "true" value). In the figure above, both (1) and (2) are equally accurate but neither is as precise as (3). By contrast, (3) is least accurate, although is the most precise.

The main difference between precision and accuracy lies in the possible presence of bias or “systematic error”. Although precision includes only random effects, accuracy comprises both random and systematic effects. Both terms are used often with the same meaning. This is because in surveying practice, in the majority of the cases, the true value is not known and only a most probable value of the population mean can be estimated via random sample measurement procedures. For the purpose of this paper both terms will have the same meaning and relate to the definition of precision. This concept is per se emphasized by the fact that geospatial data in the AMDB should be free of systematic effects (see above definition of accuracy). Further, all observed (random variable) or derived statistics should be qualified through its corresponding accuracy parameters such as variance, standard deviation, and covariance.

A measure for accuracy proposed by Gauss is the “mean square error” (MSE) given by:

$$MSE = m^2 = E[(s - E(s))^2],$$

which it can be shown to reduce to:

$$MSE = m^2 = \sigma_s^2 + (bias)^2$$

D.9 Resolution

In relation with this subject, there are two possible definitions or approaches to resolution. One is according to the RTCA/ICAO philosophy whose definition is in the Glossary of this document, and the second follows surveying science concepts and particularly the field of image processing. Within this context the following definitions are valid:

SPATIAL RESOLUTION is the capacity of the system (lens, sensor, emulsion, electronic components, etc.) to define the smallest possible object in the image. Historically, this has been measured as the number of lines pair per millimeter that can be resolved in a photograph of a bar chart. This is the also called Analogue Resolution. For the modern photogrammetric cameras equipped with Forward Motion Compensation (FMC) devices and photogrammetric Panchromatic Black and White emulsions, this resolution can (depending on contrast) be 40 to 80 lp/mm (line pairs per millimeter). In the case of space scanner sensors mounted on satellite platforms, they record the incident radiation at a series of scan lines at approximately right angles to the flight direction of the platform. Within each scan line there is a set of recorded values called the picture elements or pixels, with each pixel being the same size as the IFOV (Instantaneous Field of View). The pixel is thus the measure of the spatial resolution limit of the scanner data.

SPECTRAL RESOLUTION is the capability of a sensor to discriminate the detected radiance in different intervals of wave lengths of the electromagnetic spectrum. Hence, the spectral resolution is determined by the number of bands that a particular sensor is capable to capture and by the corresponding spectral bandwidth. In general, a sensor will be more useful with more bands and with narrow spectral bands. The photographic systems have spectral bands covering from the panchromatic Black & White (B/W), the B/W infrared, to the natural color or color infrared. The electro-optic sensors typically have larger spectral resolution. For example, Spot imagery has three bands, the NOAA-AVHRR has five, and the Landsat TM has seven.

RADIOMETRIC RESOLUTION is the capability of the sensor to discriminate levels or intensity of spectral radiance. In analogue systems such as photography, the radiometric resolution is measured based on the number of gray levels that can be obtained. In opto-electronic systems, the radiance is recorded in an array of cells. A digit is assigned to each cell proportional to the received level of energy. This is done by an analogue to digital converter in the platform. Generally in the modern sensors the range is between 0 (zero) radiance into the sensor and 255 at saturation response of the detector.

TEMPORAL RESOLUTION is the rate at which a sensor can acquire a new image of the same spot of the earth’s surface. This depends on the altitude of the orbit and on the aperture angle of observation.

When utilizing aerial photogrammetric means to capture aerodrome data, the system resolution (i.e., combination of the optical resolution of the objective lens of the camera and resolving power of the emulsion) should be chosen based on the smallest feature that needs to be captured at the flying scale. If using satellite imagery, the selection of the bands to be used should be governed by the data elements to be captured and the size of the features to be mapped in order to derive the required spatial resolution of the imagery.

D.10 References for Appendix D

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Appendix E

EXAMPLE OF AMDB EXCHANGE STRUCTURE

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Appendix E—EXAMPLE OF AMDB EXCHANGE STRUCTURE

This appendix provides an example data structure for the purpose of exchanging AMDBs. It should not be read as requirements. All requirements are given in Sections 3 and 4.

The intent of this appendix is to provide guidance material to data integrators, system designers, and end users. It can be used as an exchange structure for all features specified in Section 4 of this document. It is based on the feature and attribute definitions of this document, describes attribute coding, and provides data capture guidelines to the surveyor.

The proposed data structure can be stored in practically any data format including: ASCII, Arc/Info, Shape, Sybase, Oracle, etc. Therefore, it is compliant with OpenGIS ISO standards. It does not require any specific physical storage format. The data structure is not normalized, in order to provide an exchange platform even for the low-end systems developer.

The structure is based on conceptual aerodrome database models that have been developed previously in the Ron Brown Airport Initiative (NIMA), the aeronautical conceptual model (EUROCONTROL), the digital chart of the world (NIMA/ESRI), and the DFAD (DoD).

In contrast to these industrial models, the proposed structure is application and tool independent. It tries to combine the advantages of the models listed above. Complexity of other models is avoided. The proposed structure is open. It is simple to amend new features, attributes, or attribute coding. Only the changes have to be documented and delivered to the intended user of the database. The data structure changes would be delivered in a "data exchange report".

Finally, the document provides sufficient information for the field surveyor to capture all required data elements (features). With this compendium, a field surveyor should be able to capture all required information to drive all envisioned applications described in Appendix A.

The feature and attribute list is sufficient to support already implemented applications from Appendix A. Some information such as connectivity of taxiways is unspecified. The reason is that this would add unacceptable complexity to the database structure. It would exclude all small company low-end developers from using the database structure for data exchange. Therefore, it is assumed that a GIS such as Intergraph or Arc/Info generate this connectivity automatically on the user side.

The structure fully complies to the requirements stated in Sections 3 and 4. For applying this structure, all requirements from Sections 3 and 4 must be followed. Particularly, this is valid for the required accuracy, resolution, integrity, completeness, and applied coordinate system.

Section E.1 of this appendix explains how supplemental features can be generated and added to the required elements. Section E.2 gives a structural overview showing all features and attached attributes. In Section E.3, features, attributes, and attribute coding are provided. Finally, Section E.4 gives an example.

E.1 Supplemental Information

E.1.1 Supplemental Features

The *Optional*-field in the feature description indicates that a feature is classified as a supplemental data element. A *Yes* in the *Optional*-field indicates that this feature might be necessary for specific applications, but not for all envisioned applications. A *No* in the Optional-field indicates that this feature is mandatory information for all envisioned applications.

When adding supplemental features to the required set of AMDB features, specific rules concerning feature naming convention and mandatory information have to be adhered to. Every additional feature should be described in a Data Exchange Report file. Mandatory feature information includes *feature name, optionality, description of feature, type of geometry type, derivation method,* and *data capture rule.*

E.1.1.1 Supplemental Feature Names

Supplemental feature names should have:

- no duplicate names
- only letters from US-ASCII code (a..z)
- maximal eight letters
- only lower case letters

E.1.1.2 Minimal Information for Supplemental Features

feature name:	name of the feature
optional:	fixed value: “yes”
description of feature:	description of the feature and its geometry
geometry type:	polygon, line, or point
derivation method:	surveyed or calculated
data capture rule:	surveying rules

E.1.2 Supplemental Attributes

For each feature, all of the below defined attribute information should be provided (if not stated otherwise in the *Optional*-field). The *Optional*-field in the attribute description identicates that an attribute is classified as a supplemental data element. A *Yes* in the *Optional*-field indicates that this attribute might be necessary for specific applications, but not for all envisioned applications. A *No* in the Optional-field indicates that this attribute is mandatory information for all envisioned applications.

Adding attributes to the set of AMDB feature attributes, specific rules concerning attribute naming convention and mandatory information have to be adhered to. Every new attribute should be described in a Data Exchange Report file.

E.1.2.1 Supplemental Attribute Names

Supplemental attribute names should be according to the specification given below. To define supplemental attributes, the following rules should be obeyed:

- supplemental attribute names should end on “_s” for *supplemental*.
- no duplicate names
- only letters from US-ASCII code (a..z)
- maximal eight letters
- only lower case letters

E.1.2.2 Supplemental Attribute Types

Supplemental attribute types should be in the type specified. Following deprivations are used:

Table E-1 Attribute Types

Character	Character. Fields should not be longer than 255 characters
Integer	Integer
Float	Float
Date	ASCII. Date (DD.MM.YYYY)
Bool	Boolean. Integer value can be filled with “1” or “0”.

E.1.2.3 Minimal Attribute List for Supplemental Features

For a supplemental feature, all of the following attributes should be provided: feattype, arptid, objectid (if a unique identifier if necessary or applicable), rwyid (if a unique identifier if necessary or applicable), vacc, hacc, vres, hres, source, integr, and revdate.

E.1.2.4 Supplemental Attribute Information

For supplemental attributes following information should be provided:

- name of attribute: name of attribute
- description: description of attribute
- optional: specifies whether or not feature is required by Sections 3 or 4 of this document
- format: type of the feature
- fixed value: fixed value for this attribute (no entry choice)
- maximal length: maximal number of characters
- coding: possible entries as described in the given table
- units of measurement: meters, degree, percent, promille, etc.
- domain range: possible minimum and maximum value

E.1.2.5 Coding

All codes should be according to the specification given below.

E.1.3 Supplemental Codes

Supplemental code values should be described in the Data Exchange Report file.

E.1.3.1 Supplemental Code Values

To define supplemental codes, the following rules should be obeyed:

- new codes should be of type integer
- new attribute coding should be greater than 100
- no duplicate codes

E.1.3.2 Default Values

If no default values have been defined in the definition of the attributes, then values given below should be used. The following table lists standard values for null, unknown, not applicable, and not entered.

Table E-2 Default Values

Attribute Format	Null	Unknown	Not Applicable	Not Entered
Character	“Null”	“UNK”	“NA”	“NE”
Integer	-32768	-32767	-32765	-32764
Float	-32768.00	-37267.00	-32765.00	-32764.00
Date	00/00/0000	00/00/0000	00/00/0000	00/00/0000

E.1.4 Data Exchange Report File

- Each set of data elements should be accompanied by a data exchange report file. The Data Exchange Report File should provide information about how the aerodrome mapping data was collected, derived, structured and processed, so that reprocessing and/or quality evaluation can be performed. It may consist of several records:
- Ground Survey Records and/or
- Photogrammetric Collection Record
- Conversion, Editing and Merging Record
- Quality Control Records
- AMDB Structure Records

E.1.4.1 Ground Survey Records

Ground survey records should include a description of the procedures used for ground survey of aerodrome mapping database features and/or the survey of ground control points that are to be used in aero-triangulation. These records should include reference to the specific control information used. Points used for control should be described with sufficient detail to allow recovery of survey points (e.g., monumentation). The following details should be included (if applicable):

- Description of local geodetic network used
- Description and layout of aerodrome survey network used
- Description of connection between local geodetic network and aerodrome survey network used, including detailed description of transformation algorithms used from local, state, or national coordinate system to WGS84-coordinate system
- Description and layout of ground control points for aero-triangulation
- Type, maker, serial number, version of survey equipment (e.g., GPS or Total Station)
- Data Processing Software
- Accuracy and precision of instrumentation (calibration)
- Horizontal and vertical units
- Horizontal and vertical reference frame
- Survey date
- Collection strategy used (e.g., GPS RTK, GPS Static)
- Organization name

E.1.4.2 Photogrammetric Collection Records

These records should include a description of the procedures used in the photogrammetric collection of aerodrome mapping database features. It should include the following details (if applicable):

- Aircraft type
- Aerial camera type, maker, serial number, focal length, camera calibration certificate
- Photogrammetric flight altitude, image scale, image collection date
- Photogrammetric scanner type, maker, accuracy and resolution
- Photogrammetric feature collection software, maker and version
- Image characteristics (i.e., film type, resolution (line pairs/mm), pixel size used)
- Process date
- Triangulation method used
- Accuracy of triangulation
- Horizontal and vertical units
- Horizontal and vertical reference frame
- Description of feature collection strategies
- Organization name

E.1.4.3 Conversion, Editing and Merging Records

These records should provide a description of the conversion, merging and/or editing methods used to create aerodrome mapping databases. An aerodrome mapping database created by merging information obtained from distinct sources should be described in sufficient detail to identify the source for each element in the database. In these cases, either a lineage code on each element or a quality overlay (source data index, etc.) should be provided. For every process, these records should include the following details (if applicable):

- Software used, version, maker
- Process date
- Processing tolerances
- Special processing techniques
- Feature integration schemes
- Merging of datasets
- Organization name

E.1.4.4 Quality Control Records

These records should describe the procedures used to ensure that the aerodrome mapping database conforms to the requirements defined in the specifications. It should include the basic production quality assurance procedures (see DO-200A). For example, measures of positional accuracy may be obtained by one of the following optional methods:

- Deductive Estimate. Any deductive statement based on knowledge of errors in each production step should include reference to complete calibration tests and should also describe assumptions concerning error propagation. Results from deductive estimates should be distinguished from results of other tests.
- Internal Evidence. Tests based on repeated measurement and redundancy such as closure of traverse or residuals from an adjustment.
- Comparison to Source. When using graphic inspection of results ("check plots"), the geometric tolerances applied should be reported and the method of registration should also be described.
- Independent Source of Higher Accuracy. The preferred test for positional accuracy is a comparison to an independent source of higher accuracy. When the dates of testing and source material differ, the report should describe the procedures used to ensure that the results relate to positional error and not to temporal effects. The numerical results in ground units, as well as the number and location of the test points, should be reported. A statement of compliance to a particular threshold is not adequate in itself. This test may only be applicable to well-defined points.

E.1.4.5 AMDB Structure Records

To ensure data completeness and ease of data exchange, AMDB structure records should be provided. They provide information necessary to identify any changes from the specified structure like supplemental features, supplemental attributes, and supplemental coding.

E.2 AMDB Feature and Attribute Overview

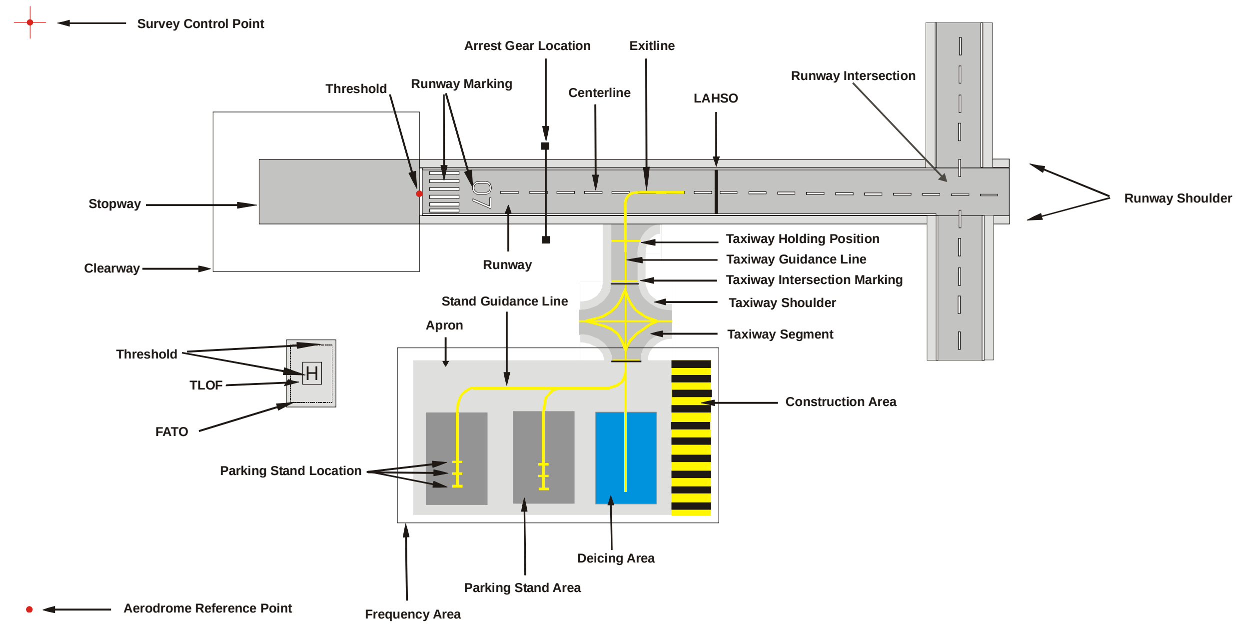


Figure E-1 AMDB Features

Table E-3 AMBD Features and Attributes

Runway	Runway Intersection	Threshold	Runway marking	Centerline	LAHSO	Arrest gear Location	Runway shoulder
Feattype	Feattype	Feattype	Feattype	Feattype	Feattype	Feattype	Feattype
Arptid	Arptid	Arptid	Arptid	Arptid	Arptid	Arptid	Arptid
Rwyid	Objected	Objectid	Objectid	Objectid	Objectid	Objectid	Objectid
Vacc	Vacc	Vacc	Vacc	Vacc	Vacc	Vacc	Vacc
Hacc	Hacc	Hacc	Hacc	Hacc	Hacc	Hacc	Hacc
Vres	Vres	Vres	Vres	Vres	Vres	Vres	Vres
Hres	Hres	Hres	Hres	Hres	Hres	Hres	Hres
Source	Source	Source	Source	Source	Source	Source	Source
Integr	Integr	Integr	Integr	Integr	Integr	Integr	Integr
Revdate	Revdate	Revdate	Revdate	Revdate	Revdate	Revdate	Revdate
PCN	PCN	TDZE			Pid	Status	Status
Width		TDZslope					Material
Length		Brngtrue					
Surftype	Surftype	Brngmag					
		Rwyslope					
		Tora					
		Toda					
		Asda					
		Lda					
		Cat					
		PapiVasi					
		Status					
		Ellipse					

Stop way	Clear way	FATO	TLOF	Helipad Threshold	Taxiway Segment	Taxiway Shoulder	Taxiway Guidance Line	Taxiway Intersection Marking
feattype	feattype	feattype	feattype	feattype	Feattype	feattype	feattype	feattype
Arptid	Arptid	arptid	arptid	arptid	arptid	arptid	arptid	arptid
objectid	objectid	objectid	objectid	objectid	objectid	objectid	objectid	objectid
vacc	vacc	vacc	vacc	vacc	vacc	vacc	vacc	vacc
hacc	hacc	hacc	hacc	hacc	hacc	hacc	hacc	hacc
vres	vres	vres	vres	vres	vres	vres	vres	vres
hres	hres	hres	hres	hres	hres	hres	hres	hres
source	source	source	source	source	source	source	source	source
integr	integr	integr	integr	integr	integr	integr	integr	integr
revdate	revdate	revdate	revdate	revdate	Revdate	revdate	revdate	revdate
status		material	material	status	material	material	Status	
material				ellipse	pcn	status	wingspan	
							maxpeed	
							direc	

Taxiway Holding Position	Exitline	Frequency Area	Apron	Stand Guidance Line	Parking Stand Location	Parking Stand Area
feattype	feattype	feattype	feattype	feattype	feattype	feattype
arptid	arptid	arptid	arptid	arptid	arptid	arptid
objectid	objectid	hacc	vacc	objectid	objectid	vacc
vacc	vacc	hres	hacc	vacc	vacc	hacc
hacc	hacc	source	vres	hacc	hacc	vres
vres	vres	integr	hres	vres	vres	hres
hres	hres	revdate	source	hres	hres	source
source	source	frq	integr	source	source	integr
integr	integr	station	revdate	integr	integr	revdate
revdate	revdate		material	revdate	revdate	material
status	Status		pcn	Status	acn	pcn
cat	direc		status	direc		standid
rwyid				wingspan		jetway
						fuel
						towing
						docking
						gndpower

Deicing Area	Aerodrome Reference Point	Vertical Polygon Structure	Vertical Point Structure	Vertical Line Structure	Construction Area	Survey Control Point
feattype	feattype	feattype	feattype	feattype	feattype	feattype
arptid	arptid	arptid	arptid	arptid	arptid	arptid
vacc	vacc	objectid	objectid	objectid	hacc	vacc
hacc	hacc	vacc	vacc	vacc	hres	hacc
vres	vres	hacc	hacc	hacc	source	vres
hres	hres	vres	vres	vres	integr	hres
source	source	hres	hres	hres	revdate	source
integr	integr	source	source	source		integr
revdate	revdate	integr	integr	integr		revdate
material	revdate	revdate	revdate	revdate		coord
		material	material	material		date
		height	height	height		sheroid
		elev	elev	elev		
			lighting	lighting		
			radius	marking		
			marking			

E.3 AMDB Features

If not indicated otherwise by the *Optional*-field, the following set of features should be provided.

E.3.1 Runway

E.3.1.1 Runway Feature Definition

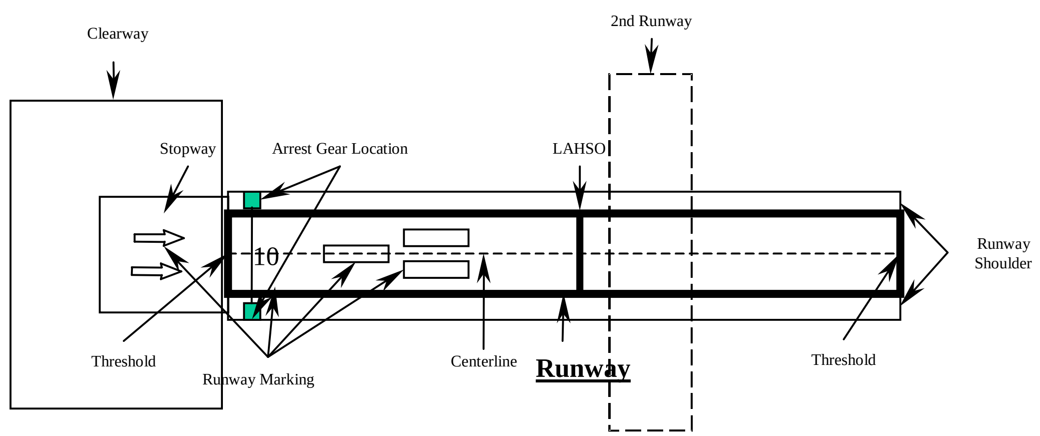


Figure E-2 Runway Feature

Feature Name:	**runway**
Optional:	No
Description of Feature:	See definition runway: ICAO Annex 14, Chapter 1.1
Geometry Type:	Polygon
Derivation Method:	Surveyed

Data capture rule: All runways at an aerodrome should be captured as individual objects. The runway polygon be delimited by the outer edge of the white runway edge painting, excluding runway shoulders and stopways. All runway information that is related to a landing directon should be attached to the corresponding threshold (eg information for RWY 25 will be attached to the threshold point feature for the landing direction 25).

Attributes:

Name	Description
feattype	Runway feature type
arptid	ICAO aerodrome location indicator
rwytid	Object identifier
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of last revision or generation of source data
pcn	pcn number of runway
width	width of the runway
length	length of the runway
material	Predominant surface type of the runway

E.3.1.2 Runway Feature Attribute Definition

E.3.1.2.1 feattype

Name of attribute: **feattype**
Description: feature type
Optional: No
Format: Character
Fixed Value: “runway”
Maximal Length: 32

E.3.1.2.2 arptid

Name of attribute: **arptid**
Description: ICAO aerodrome location indicator
Optional: No
Format: Character
Maximal Length: 5
Coding: ICAO aerodrome designator (4-letter code)
Example: KIAD

E.3.1.2.3 rwyid

Name of attribute:	**rwyid**
Description:	unique object identifier
Optional:	No
Format:	Character
Maximal Length:	15
Coding:	Runway-designator of both runway directions, separated by a “.“. (beginning with smaller number). *Example: 07L.25R*

E.3.1.2.4 vacc

Name of attribute:	**vacc**
Description:	vertical accuracy of entity as a 95% LE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00–99.99

5.3.1.2.5 hacc

Name of attribute:	**hacc**
Description:	horizontal accuracy of entity as a 95% CE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.1.2.6 vres

Name of attribute:	**vres**
Description:	vertical resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00–9.99

E.3.1.2.7 hres

Name of attribute:	**hres**
Description:	horizontal resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	Decimal Degrees
Domain Range:	0.00000001-0.001

E.3.1.2.8 source

Name of attribute:	**source**
Description:	Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional:	No
Format:	Character
Maximal Length:	50

E.3.1.2.9 integr

Name of attribute:	**integr**
Description:	Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional:	No
Format:	Float
Domain Range:	0 – 1

E.3.1.2.10 revdate

Name of attribute:	**revdate**
Description:	Date of origination or last revision of data.
Optional:	No
Format:	Date

E.3.1.2.11 pcn

Name of attribute:	**pcn**
Description:	Weight bearing capability of runway.
Optional:	No
Format:	Character
Maximal Length:	30
Coding:	Aircraft classification number – pavement classification number ACN-PCN. The format is specified in ICAO Annex 14, Chapter 2.6 *Example: PCN80/R/B/W/T*

E.3.1.2.12 width

Name of attribute:	**width**
Description:	Average width of runway
Optional:	No
Derivation Method:	calculated
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00 – 100.00

E.3.1.2.13 length

Name of attribute:	**length**
Description:	length of runway polygon.
Optional:	No
Derivation Method:	calculated
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00 – 99999.99

E.3.1.2.14 material

Name of attribute:	**material**
Description:	Predominant surface type of runway.
Optional:	No
Format:	Integer

Coding:

Code	Material
1	Concrete grooved
2	Concrete nongrooved
3	Asphalt grooved
4	Asphalt nongrooved
5	Desert / Sand
6	Bare earth
7	Snow/Ice
8	Water
9	Grass

Example for concrete grooved: 1

E.3.2 Runway Intersection

E.3.2.1 Runway Intersection Feature Definition

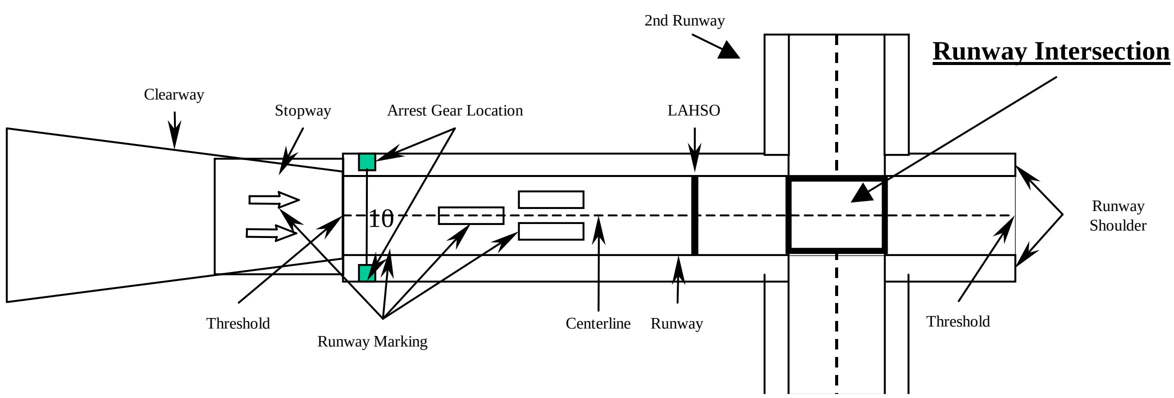


Figure E-3 Runway Intersection Feature

Feature Name:	**runway intersection**
Optional:	No
Description of Feature:	Intersecting area of two or more runways or runway and stopway, not including runway shoulders.
Geometry Type:	Polygon
Derivation Method:	Surveyed
Data capture rule:	All runway intersections at an aerodrome should be captured as individual objects. The runway intersection polygon is delimited by the outer edge of the white runway edge painting, excluding runway shoulders.

Attributes:

Name	Description
feattype	Runway feature type
arptid	ICAO aerodrome location identifier
objectid	Object identifier
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of last revision or generation of data source
pcn	pcn number of runway intersection
material	Predominant surface material of the runway intersection

E.3.2.2 Runway Intersection Feature Attribute Definition

E.3.2.2.1 feattype

Name of attribute: **feattype**
Description: feature type
Optional: No
Format: Character
Fixed Value: “runway intersection”
Maximal Length: 32

E.3.2.2.2 arptid

Name of attribute: **arptid**
Description: ICAO aerodrome location identifier
Optional: No
Format: Character
Maximal Length: 5
Coding: ICAO aerodrome designator (4-letter code)
Example: KIAD

E.3.2.2.3 objectid

Name of attribute: **objectid**
Description: object identifier
Optional: No
Format: Character
Maximal Length: 22
Coding: object-identifier (objectid) of intersecting runways or stopways (see 9.3.1.2.3 and 9.3.9.2.3), separated by a “_“.
Example: Intersection of Runway 07.25 and 18.36: *07.25_18.36*
Intersection of Runway 12L.30R and Stop-way 18: *12L.30R_18*

E.3.2.2.4 vacc

Name of attribute:	**vacc**
Description:	vertical accuracy of entity as a 95% LE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00–99.99

E.3.2.2.5 hacc

Name of attribute:	**hacc**
Description:	horizontal accuracy of entity as a 95% CE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.2.2.6 vres

Name of attribute:	**vres**
Description:	vertical resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00–9.99

E.3.2.2.7 hres

Name of attribute:	**hres**
Description:	horizontal resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	Decimal Degrees
Domain Range:	0.00000001-0.001

E.3.2.2.8 source

Name of attribute:	**source**
Description:	Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional:	No
Format:	Character
Maximal Length:	50

E.3.2.2.9 integr

Name of attribute:	**integr**
Description:	Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional:	No
Format:	Float
Domain Range:	0 – 1

E.3.2.2.10 revdate

Name of attribute: **revdate**
Description: Date of origination or last revision of data.
Optional: No
Format: Date

E.3.2.2.11 pcn

Name of attribute: **pcn**
Description: Weight bearing capability of runway intersection.
Optional: No
Format: Character
Maximal Length: 30
Coding: Aircraft classification number – pavement classification number ACN-PCN. The format is specified in ICAO Annex 14, Chapter 2.6
Example: PCN80/R/B/W/T

E.3.2.2.12 material

Name of attribute: **material**
Description: Predominant Predominant surface material of runway intersection.
Optional: No
Format: Integer
Coding:

Code	Material
1	Concrete grooved
2	Concrete nongrooved
3	Asphalt grooved
4	Asphalt nongrooved
5	Desert/Sand
6	Bare earth
7	Snow/Ice
8	Water
9	Gras

Example for concrete grooved: 1

E.3.3 Threshold

E.3.3.1 Threshold Feature Definition

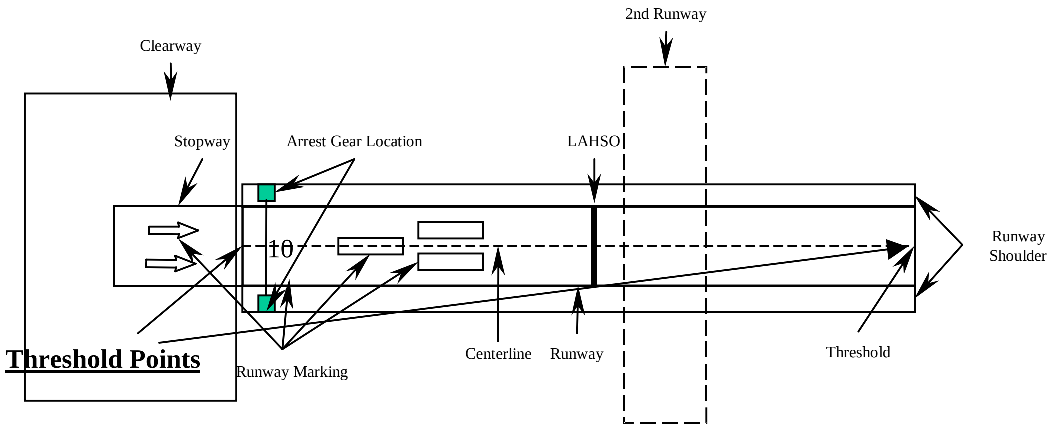


Figure E-4 Threshold Feature

Feature Name:	**threshold**
Optional:	No
Description of Feature:	See definition threshold: ICAO Annex 14, Chapter 1.1
Geometry Type:	Point
Derivation Method:	Surveyed
Data capture rule:	The threshold points should be located according ICAO Doc 9674 (WGS84)-Manual, Chapter 5). All runway information that is related to a landing direction should be attached to the corresponding threshold point as attributes. Thresholds should be surveyed in all 3 dimensions.

Attributes:

Name	Description
feattype	Threshold feature type
arptid	ICAO aerodrome location indicator
objectid	Object identifier
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data.
integr	Data integrity.
revdate	Date of origination or last revision of data.
tdze	touchdown zone elevation corresponding to threshold location.
tdzslope	touchdown zone longitudinal slope corresponding to threshold location.
brngtrue	true runway bearing corresponding to landing direction.
brngmag	magnetic runway bearing corresponding to threshold location valid at the day of data generation
rwyslope	Rwy slope corresponding to landing direction
tora	take-off run available corresponding to threshold location.
toda	take-off distance available corresponding to threshold location.
asda	accelerate-stop distance available corresponding to threshold location.
lda	landing distance available corresponding to threshold location.
cat	Precision approach guidance system available corresponding to threshold location
papivasi	Veritical guidance lighting system available corresponding to threshold location
status	Permanent state of runway in corresponding takeoff/landing-direction.
ellipse	Ellipsoidal elevation of threshold point

E.3.3.2 Threshold Feature Attribute Definition

E.3.3.2.1 feattype

Name of attribute:	**feattype**
Description:	feature type
Optional:	No
Format:	Character
Fixed Value:	“threshold”
Maximal Length:	32

E.3.3.2.2 arptid

Name of attribute: **arptid**
Description: ICAO aerodrome location indicator
Optional: No
Format: Character
Maximal Length: 5
Coding: ICAO aerodrome designator (4-letter code)
Example: KIAD

E.3.3.2.3 objectid

Name of attribute: **objectid**
Description: unique object identifier
Optional: No
Format: Character
Maximal Length: 15
Coding: Runway-designator of corresponding runway direction.
Example: 07L

E.3.3.2.4 vacc

Name of attribute: **vacc**
Description: vertical accuracy of entity as a 95% LE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.3.2.5 hacc

Name of attribute: **hacc**
Description: horizontal accuracy of entity as a 95% CE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.3.2.6 vres

Name of attribute: **vres**
Description: vertical resolution of coordinates defining the feature
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 9.99

E.3.3.2.7 hres

Name of attribute: **hres**
Description: horizontal resolution of coordinates defining the feature
Optional: No
Format: Float
Units of Measurement: Decimal Degrees
Domain Range: 0.00000001-0.001

E.3.3.2.8 source

Name of attribute:	**source**
Description:	Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional:	No
Format:	Character
Maximal Length:	50

E.3.3.2.9 integr

Name of attribute:	**integr**
Description:	Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional:	No
Format:	Float
Domain Range:	0 – 1

E.3.3.2.10 revdate

Name of attribute:	**revdate**
Description:	Date of origination or last revision of data.
Optional:	No
Format:	Date

E.3.3.2.11 tdze

Name of Attribute:	**tdze**
Description:	touchdown zone (ICAO Annex 14, Chapter 1.1) elevation (Orthometric elevation) corresponding to threshold location.
Optional:	No
Derivation Method:	surveyed
Format:	Float
Units of Measurement:	meters
Domain Range:	-500.00 – 9000.00

E.3.3.2.12 tdzslope

Name of Attribute:	**tdzslope**
Description:	touchdown zone longitudinal slope (slope of 1/3 of the rwy length from threshold or first 1000 meters (3000 feet) for rwys longer than 3000 meters (9000 feet), corresponding to threshold location (FAA AC-150/5300-13 Ch6).
Optional:	No
Derivation Method:	calculated
Format:	Float
Units of Measurement:	per cent
Domain Range:	0.00 – 100.00

E.3.3.2.13 brngtrue

Name of Attribute: **brngtrue**
Description: True bearing corresponding to landing direction (ICAO Annex 14, Chapter 3.1.12)
Optional: No
Derivation Method: calculated
Format: Float
Units of Measurement: degree
Domain Range: 0.00 – 359.99

E.3.3.2.14 brngmag

Name of Attribute: **brngmag**
Description: magnetic runway bearing corresponding to threshold location valid at the day of data generation
Optional: No
Derivation Method: surveyed
Format: Float
Units of Measurement: degree
Domain Range: 0.00 – 359.99

E.3.3.2.15 rwyslope

Name of Attribute: **rwyslope**
Description: Rwy slope corresponding to landing direction
Optional: No
Derivation Method: surveyed
Format: Float
Units of Measurement: per cent
Domain Range: 0.00 – 100.00

E.3.3.2.16 tora

Name of Attribute: **tora**
Description: take-off run available (ICAO Annex 14, Chapter 1.1) corresponding to threshold location.
Optional: No
Derivation Method: surveyed
Format: Float
Units of Measurement: meters
Domain Range: 0.00 – 9999.99

E.3.3.2.17 toda

Name of Attribute: **toda**
Description: take-off distance available (ICAO Annex 14, Chapter 1.1) corresponding to threshold location.
Optional: No
Derivation Method: surveyed
Format: Float
Units of Measurement: meters
Domain Range: 0.00 – 9999.99

E.3.3.2.18 asda

Name of Attribute: **asda**
Description: accelerate-stop distance available. (ICAO Annex 14, Chapter 1.1) corresponding to threshold location.
Optional: No
Derivation Method: surveyed
Format: Float
Units of Measurement: meters
Domain Range: 0.00 – 9999.99

E.3.3.2.19 lda

Name of Attribute: **lda**
Description: landing distance available (ICAO Annex 14, Chapter 1.1) corresponding to threshold location.
Optional: No
Derivation Method: surveyed
Format: Float
Units of Measurement: meters
Domain Range: 0.00 – 9999.99

E.3.3.2.20 cat

Name of Attribute: **cat**
Description: Precision approach guidance system available corresponding to threshold location.
Optional: No
Format: Integer
Coding:

Code	Value ICAO Annex 14, Chapter 5.3.4
0	non precision approach runway
1	ILS precision approach runway, category I
2	ILS precision approach runway, category II
3	ILS precision approach runway category III A
4	ILS precision approach runway category III B
5	ILS precision approach runway category III C
6	ILS precision approach runway category III D
7	MLS precision approach

E.3.3.3 papivasi

Name of Attribute: **papivasi**
Description: Veritical guidance lighting system available corresponding to threshold location.
Optional: No
Format: Integer
Coding:

Code	Value ICAO Annex 14, Chapter 5.3.5
0	No visual slope indicator systems
1	PAPI
2	APAPI
3	T-VASIS
4	AT-VASIS

E.3.3.3.1 status

Name of Attribute: **status**
Description: Permanent state of runway (exceeding the AIRAC-cycle of 56 days) in corresponding takeoff/landing-direction: open or closed. Non-permanent runway-closures of less than 56 days are not adressed in the AMDB but will be adressed via NOTAMS.
Optional: No
Format: Bool
Coding: open (1); closed (0)

E.3.3.3.2 ellipse

Name of Attribute: **ellipse**
Description: Ellipsoidall elevation of runway threshold.
Optional: No
Derivation Method: surveyed
Format: Float
Units of Measurement: meters
Domain Range: -1000.00 – 9000.00

E.3.4 Runway Marking

E.3.4.1 Runway Marking Feature Definition

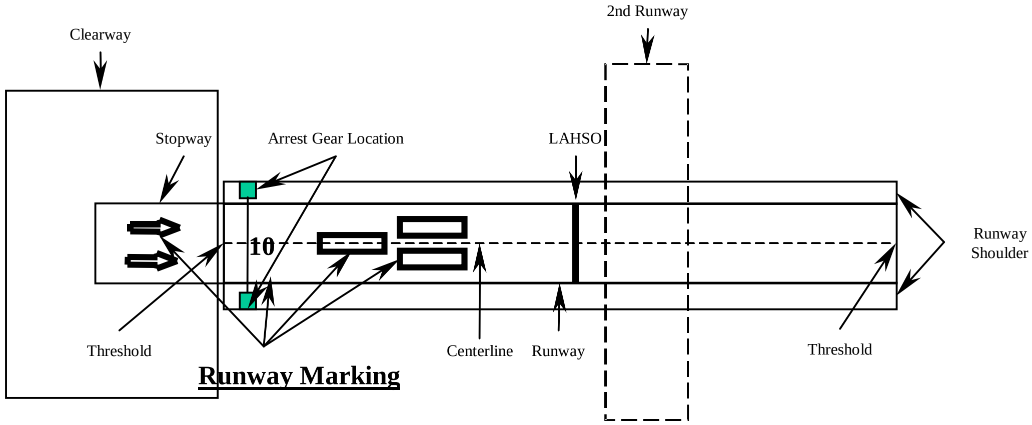


Figure E-5 Runway Marking Feature

Feature Name: **runway marking**
Optional: No
Description of Feature: The runway marking feature should include runway designation marking, runway centerline marking, threshold marking, traverse stripes, touchdown zone marking and runway side stripe marking. If applicable, heliport marking should also be included.
Geometry Type: Polygon
Derivation Method: Surveyed
Data capture rule: Use outer edges of contours of white markings painted on runway. The runway marking feature consist of multiple polygons forming the overall runway marking.

Attributes:

Name	Description
feattype	Runway marking feature type
arptid	ICAO aerodrome location indicator
objectid	Object identifier
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of origination or last revision of data.

E.3.4.2 Runway Marking Feature Attribute Definition

E.3.4.2.1 feattype

Name of attribute:	**feattype**
Description:	feature type
Optional:	No
Format:	Character
Fixed Value:	“runway marking”
Maximal Length:	32

E.3.4.2.2 arptid

Name of attribute:	**arptid**
Description:	ICAO aerodrome location indicator
Optional:	No
Format:	Character
Maximal Length:	5
Coding:	ICAO aerodrome designator (4-letter code) *Example: KIAD*

E.3.4.2.3 objectid

Name of attribute:	**objectid**
Description:	object identifier
Optional:	No
Format:	Character
Maximal Length:	15
Coding:	Runway-designator of both runway direction, separated by a “.“. (beginning with smaller number). *Example: 07L.25R*

E.3.4.2.4 vacc

Name of attribute:	**vacc**
Description:	vertical accuracy of entity as a 95% LE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.4.2.5 hacc

Name of attribute:	**hacc**
Description:	horizontal accuracy of entity as a 95% CE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.4.2.6 vres

Name of attribute:	**vres**
Description:	vertical resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 9.99

E.3.4.2.7 hres

Name of attribute: **hres**
Description: horizontal resolution of coordinates defining the feature
Optional: No
Format: Float
Units of Measurement: Decimal Degrees
Domain Range: 0.00000001-0.001

E.3.4.2.8 source

Name of attribute: **source**
Description: Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional: No
Format: Character
Maximal Length: 50

E.3.4.2.9 integr

Name of attribute: **integr**
Description: Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional: No
Format: Float
Domain Range: 0 – 1

E.3.4.2.10 revdate

Name of attribute: **revdate**
Description: Date of origination or last revision of data.
Optional: No
Format: Date

E.3.5 Centerline

E.3.5.1 Centerline Feature Definition

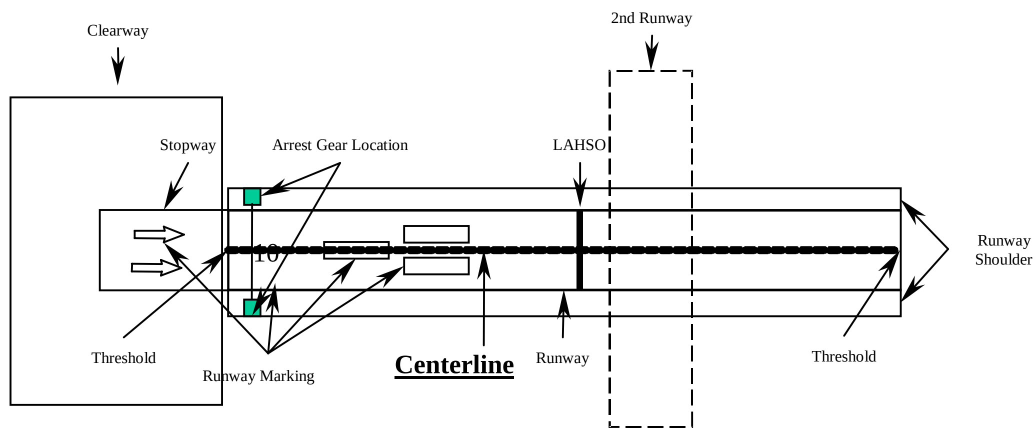


Figure E-6 Centerline Feature

Feature Name: **centerline**
Optional: No
Description of Feature: Continuous line along the painted centerline of a runway connecting the two outermost thresholds.
Geometry Type: Line
Derivation Method: Surveyed
Data capture rule: Centerline data should be captured in all 3 dimensions. Sufficient data should be provided to calculate touch-downzone slope and runway slope to the required accuracy. The line representing the centerline feature should be located in the center of the real-world centerline.
Attributes:

Name	Description
feattype	Centerline feature type
arptid	ICAO aerodrome location indicator
objectid	Object identifier
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of origination or last revision of data

E.3.5.2 Centerline Feature Attribute Definition

E.3.5.2.1 feattype

Name of attribute: **feattype**
Description: feature type
Optional: No
Format: Character
Fixed Value: “centerline”
Maximal Length: 32

E.3.5.2.2 arptid

Name of attribute: **arptid**
Description: ICAO aerodrome location indicator
Optional: No
Format: Character
Maximal Length: 5
Coding: ICAO aerodrome designator (4-letter code)
Example: KIAD

E.3.5.2.3 objectid

Name of attribute:	**objectid**
Description:	unique object identifier
Optional:	No
Format:	Character
Maximal Length:	15
Coding:	Runway-designator of both runway direction, separated by a “.“. (beginning with smaller number). *Example: 07L.25R*

E.3.5.2.4 vacc

Name of attribute:	**vacc**
Description:	vertical accuracy of entity as a 95% LE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.5.2.5 hacc

Name of attribute:	**hacc**
Description:	horizontal accuracy of entity as a 95% CE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.5.2.6 vres

Name of attribute:	**vres**
Description:	vertical resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 9.99

E.3.5.2.7 hres

Name of attribute:	**hres**
Description:	horizontal resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	Decimal Degrees
Domain Range:	0.00000001-0.001

E.3.5.2.8 source

Name of attribute:	**source**
Description:	Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional:	No
Format:	Character
Maximal Length:	50

E.3.5.2.9 integr

Name of attribute: **integr**
Description: Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional: No
Format: Float
Domain Range: 0 – 1

E.3.5.2.10 revdate

Name of attribute: **revdate**
Description: Date of origination or last revision of data.
Optional: No
Format: Date

E.3.6 Land and Hold Short Operations (LAHSO) Location

E.3.6.1 LAHSO Feature Definition

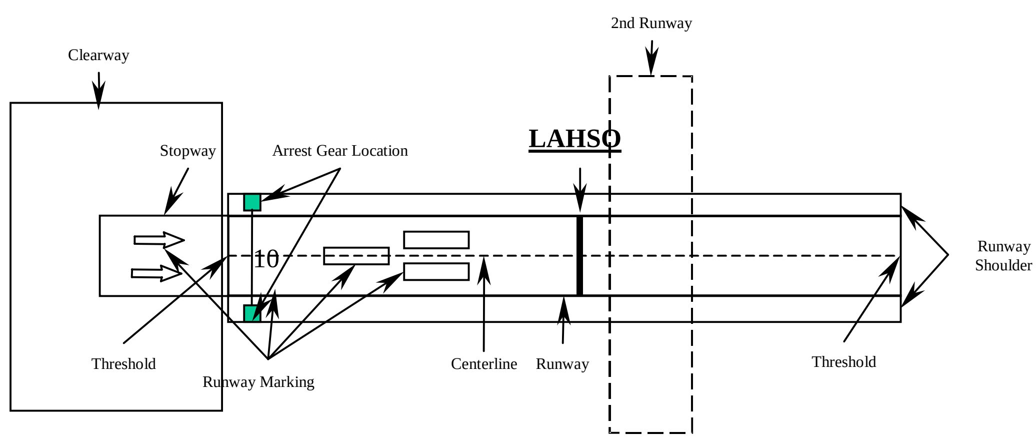


Figure E-7 **LAHSO Feature**

Feature Name: **LAHSO**
Optional: No
Description of Feature: Location of marking used for Land and hold short Operations (LAHSO).
Geometry Type: Line
Derivation Method: Surveyed
Data capture rule: Line representating the center of the LAHSO marking.

Attributes:

Name	Description
feattype	LAHSO feature type
arptid	ICAO aerodrome location indicator
objectid	Object identifier
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of origination or last revision of data

E.3.6.2 LAHSO Feature Attribute Definition

E.3.6.2.1 feattype

Name of attribute: **feattype**
Description: feature type
Optional: No
Format: Character
Fixed Value: “lahso”
Maximal Length: 32

E.3.6.2.2 arptid

Name of attribute: **arptid**
Description: ICAO aerodrome location indicator
Optional: No
Format: Character
Maximal Length: 5
Coding: ICAO aerodrome designator (4-letter code)
Example: KIAD

E.3.6.2.3 objectid

Name of attribute: **objectid**
Description: object identifier
Optional: No
Format: Character
Maximal Length: 15
Coding: Runway-designator of corresponding runway direction.
Example: 07L

E.3.6.2.4 vacc

Name of attribute: **vacc**
Description: vertical accuracy of entity as a 95% LE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.6.2.5 hacc

Name of attribute:	**hacc**
Description:	horizontal accuracy of entity as a 95% CE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.6.2.6 vres

Name of attribute:	**vres**
Description:	vertical resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 9.99

E.3.6.2.7 hres

Name of attribute:	**hres**
Description:	horizontal resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	Decimal Degrees
Domain Range:	0.00000001-0.001

E.3.6.2.8 source

Name of attribute:	**source**
Description:	Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional:	No
Format:	Character
Maximal Length:	50

E.3.6.2.9 integr

Name of attribute:	**integr**
Description:	Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional:	No
Format:	Float
Domain Range:	0 – 1

E.3.6.2.10 revdate

Name of attribute:	**revdate**
Description:	Date of origination or last revision of data.
Optional:	No
Format:	Date

E.3.6.2.11 pid

Name of attribute: **pid**
Description: Name of runway or taxiway being protected
Optional: No
Format: Character
Maximum Length: 15
Coding: *Example: 07L.25R*

E.3.7 Arrest Gear Location

E.3.7.1 Arrest Gear Location Feature Definition

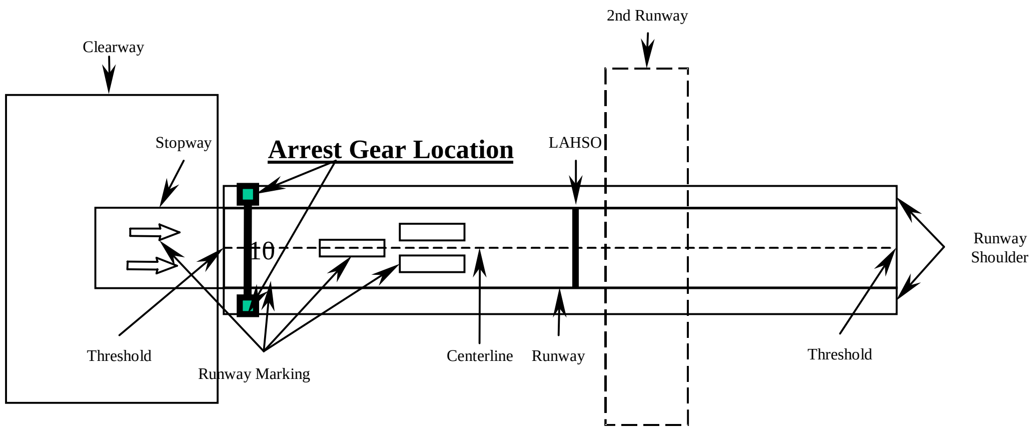


Figure E-8 Arrest Gear Feature

Feature Name: **Arrest Gear Location**
Optional: No
Description of Feature: Location of the arresting gear cable across the runway
Geometry Type: Line
Derivation Method: Surveyed
Data capture rule: Line connecting the two fixpoints of the arrest gear cable on each side of the runway.

Attributes:

Name	Description
feattype	Arrest Gear Location feature type
Arptid	ICAO aerodrome location indicator
objectid	Object identifier
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of origination or last revision of data
status	Permanent state of arrest gear

E.3.7.2 Arrest Gear Location Feature Attribute Definition

E.3.7.2.1 feattype

Name of attribute:	**feattype**
Description:	feature type
Optional:	No
Format:	Character
Fixed Value:	“arrest gear”
Maximal Length:	32

E.3.7.2.2 arptid

Name of attribute:	**arptid**
Description:	ICAO aerodrome location indicator
Optional:	No
Format:	Character
Maximal Length:	5
Coding:	ICAO aerodrome designator (4-letter code) *Example: KIAD*

E.3.7.2.3 objectid

Name of attribute:	**objectid**
Description:	object identifier
Optional:	No
Format:	Character
Maximal Length:	15
Coding:	Runway-designator of corresponding runway direction. *Example: 07L*

E.3.7.2.4 vacc

Name of attribute:	**vacc**
Description:	vertical accuracy of entity as a 95% LE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.7.2.5 hacc

Name of attribute:	**hacc**
Description:	horizontal accuracy of entity as a 95% CE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.7.2.6 vres

Name of attribute:	**vres**
Description:	vertical resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 9.99

E.3.7.2.7 hres

Name of attribute: **hres**
Description: horizontal resolution of coordinates defining the feature
Optional: No
Format: Float
Units of Measurement: Decimal Degrees
Domain Range: 0.00000001–0.001

E.3.7.2.8 source

Name of attribute: **source**
Description: Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional: No
Format: Character
Maximal Length: 50

E.3.7.2.9 integr

Name of attribute: **integr**
Description: Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional: No
Format: Float
Domain Range: 0 – 1

E.3.7.2.10 revdate

Name of attribute: **revdate**
Description: Date of origination or last revision of data.
Optional: No
Format: Date

E.3.7.2.11 status

Name of Attribute: **status**
Description: Permanent state of arrest gear: operativ or inoperativ.
Optional: No
Format: Bool
Coding: operativ (1) or inoperativ (0)

E.3.8 Runway Shoulder

E.3.8.1 Runway Shoulder Feature Definition

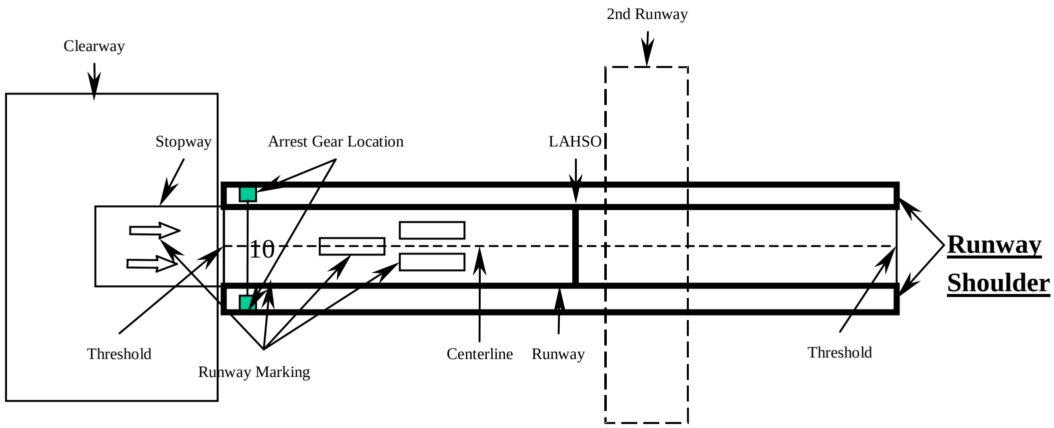


Figure E-9 Runway Shoulder Feature

Feature Name: **runway shoulder**
Optional: No
Description of Feature: Shoulder of a runway (see definition: ICAO Annex 14, Chapter 1.1).
Geometry Type: Polygon.
Derivation Method: Surveyed
Data capture rule: The runway shoulder should exclude the white runway edge painting. It typically consists of multiple polygons forming the overall shoulder on each side of the runway.

Attributes:

Name	Description
feattype	Runway shoulder feature type
Arptid	ICAO aerodrome location indicator
objectid	Object identifier
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of origination or last revision of data
status	Permanent state of runway shoulder
material	Predominant surface type

E.3.8.2 Runway Shoulder Attribute Definition

E.3.8.2.1 feattype

Name of attribute:	**feattype**
Description:	feature type
Optional:	No
Format:	Character
Fixed Value:	"runway shoulder"
Maximal Length:	32

E.3.8.2.2 arptid

Name of attribute:	**arptid**
Description:	ICAO aerodrome location indicator
Optional:	No
Format:	Character
Maximal Length:	5
Coding:	ICAO aerodrome designator (4-letter code) *Example: KIAD*

E.3.8.2.3 objectid

Name of attribute:	**objectid**
Description:	object identifier
Optional:	No
Format:	Character
Maximal Length:	15
Coding:	Runway-designator of both runway direction, separated by a ".". (beginning with smaller number). *Example: 07L.25R*

E.3.8.2.4 vacc

Name of attribute:	**vacc**
Description:	vertical accuracy of entity as a 95% LE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.8.2.5 hacc

Name of attribute:	**hacc**
Description:	horizontal accuracy of entity as a 95% CE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.8.2.6 vres

Name of attribute:	**vres**
Description:	vertical resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 9.99

E.3.8.2.7 hres

Name of attribute: **hres**
Description: horizontal resolution of coordinates defining the feature
Optional: No
Format: Float
Units of Measurement: Decimal Degrees
Domain Range: 0.00000001–0.001

E.3.8.2.8 source

Name of attribute: **source**
Description: Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional: No
Format: Character
Maximal Length: 50

E.3.8.2.9 integr

Name of attribute: **integr**
Description: Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional: No
Format: Float
Domain Range: 0 – 1

E.3.8.2.10 revdate

Name of attribute: **revdate**
Description: Date of origination or last revision of data.
Optional: No
Format: Date

E.3.8.2.11 status

Name of Attribute: **status**
Description: Permanent state of runway shoulder: usable or unusable.
Optional: No
Format: Bool
Coding: usable (1) or unusable (0)

E.3.8.2.12 material

Name of attribute: **material**
Description: Predominant surface type of runway shoulder
Optional: No
Format: Integer
Coding:

Code	Material
1	Concrete
2	Asphalt

Example for concrete: 1

E.3.9 Stopway

E.3.9.1 Stopway Feature Definition

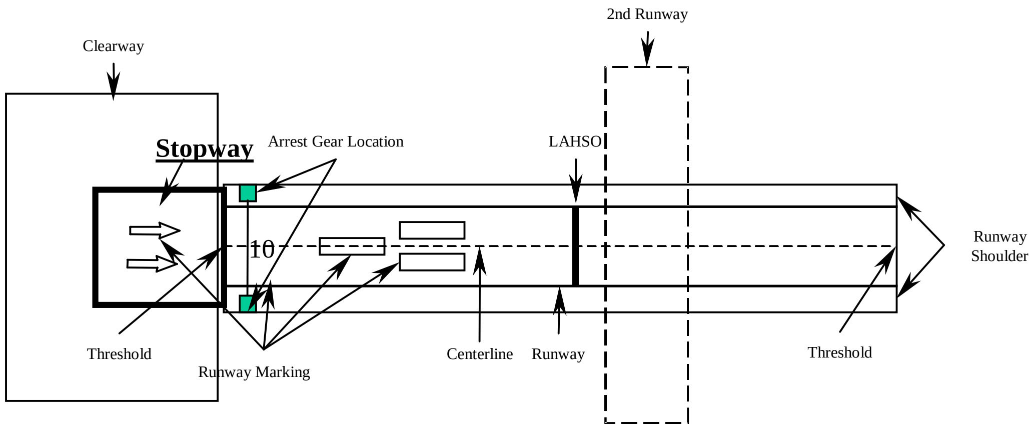


Figure E-10 Stopway Feature

Feature Name: **stopway**
Optional: No
Description of Feature: see definition stopway: ICAO Annex 14, Chapter 1.1.
Geometry Type: Polygon
Derivation Method: Surveyed
Data capture rule: A stopway is attached to the threshold of the corresponding runway. Stopway shoulders do not exist. If a painted line separates a shoulder from the stopway, the shoulder should be part of the stopway polygon.

Attributes:

Name	Description
feattype	Stopway feature type
Arptid	ICAO aerodrome location indicator
objectid	Object identifier
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of origination or last revision of data
status	Permanent state of stopway
material	Predominant surface type

E.3.9.2 Stopway Attribute Definition

E.3.9.2.1 feattype

Name of attribute:	**feattype**
Description:	feature type
Optional:	No
Format:	Character
Fixed Value:	“stopway”
Maximal Length:	32

E.3.9.2.2 arptid

Name of attribute:	**arptid**
Description:	ICAO aerodrome location indicator
Optional:	No
Format:	Character
Maximal Length:	5
Coding:	ICAO aerodrome designator (4-letter code) *Example: KIAD*

E.3.9.2.3 objectid

Name of attribute:	**objectid**
Description:	object identifier
Optional:	No
Format:	Character
Maximal Length:	15
Coding:	Runway-designator of corresponding runway direction. *Example: 07L*

E.3.9.2.4 vacc

Name of attribute:	**vacc**
Description:	vertical accuracy of entity as a 95% LE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.9.2.5 hacc

Name of attribute:	**hacc**
Description:	horizontal accuracy of entity as a 95% CE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.9.2.6 vres

Name of attribute:	**vres**
Description:	vertical resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 9.99

E.3.9.2.7 hres

Name of attribute:	**hres**
Description:	horizontal resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00000001–0.001

E.3.9.2.8 source

Name of attribute:	**source**
Description:	Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional:	No
Format:	Character
Maximal Length:	50

E.3.9.2.9 integr

Name of attribute:	**integr**
Description:	Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional:	No
Format:	Float
Domain Range:	0 – 1

E.3.9.2.10 revdate

Name of attribute:	**revdate**
Description:	Date of origination or last revision of data.
Optional:	No
Format:	Date

E.3.9.2.11 status

Name of Attribute:	**status**
Description:	Permanent state of stopway (exceeding AMDB update cycle): usable or unusable.
Optional:	No
Format:	Bool
Coding:	usable (1) or unusable (0)

E.3.9.2.12 material

Name of attribute:	**material**
Description:	Predominant surface type of stopway
Optional:	No
Format:	Integer

Coding:

Code	Material
1	Concrete grooved
2	Concrete nongrooved
3	Asphalt grooved
4	Asphalt nongrooved
5	Desert/Sand
6	Bare earth
7	Snow/Ice

Example for concrete grooved: 1

E.3.10 Clearway

E.3.10.1 Clearway Feature Definition

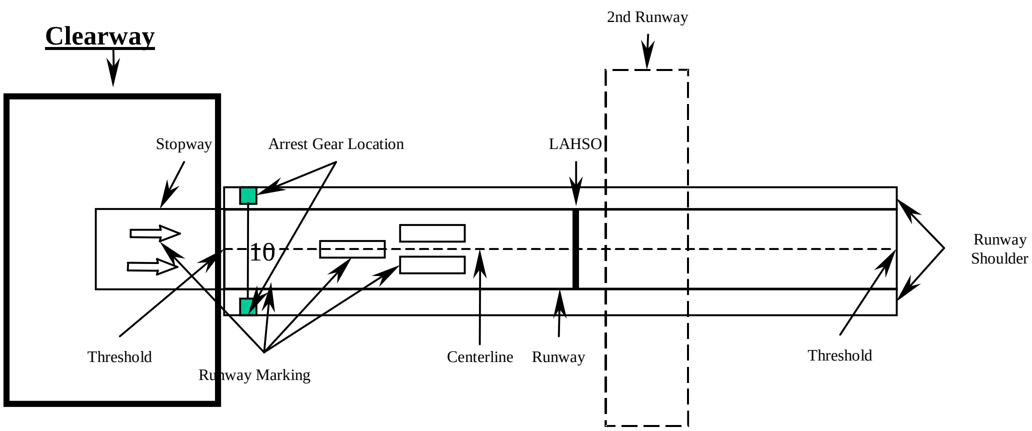


Figure E-11 Clearway Feature

Feature Name: **clearway**
Optional: No
Description of Feature: see definition clearway: ICAO Annex 14, Chapter 1.1.
Geometry Type: Polygon
Derivation Method: Surveyed
Data capture rule: A clearway is attached to the threshold of the corresponding runway or to the end of a corresponding stopway as defined by ICAO Annex 14, Chapter 1.1. Its shape should be as defined in ICAO Annex 14. The clearway´s width should not exceed 75 m to each side of the runway; its length should not exceed half of the runway length.

Attributes:

Name	Description
feattype	Clearway feature type
Arptid	ICAO aerodrome location indicator
objectid	Object identifier
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of origination or last revision of data

E.3.10.2 Clearway Attribute Definition

E.3.10.2.1 feattype

Name of attribute: **feattype**
Description: feature type
Optional: No
Format: Character
Fixed Value: “clearway”
Maximal Length: 32

E.3.10.2.2 arptid

Name of attribute: **arptid**
Description: ICAO aerodrome location indicator
Optional: No
Format: Character
Maximal Length: 5
Coding: ICAO aerodrome designator (4-letter code)
Example: KIAD

E.3.10.2.3 objectid

Name of attribute: **objectid**
Description: object identifier
Optional: No
Format: Character
Maximal Length: 15
Coding: Runway-designator of corresponding runway direction.
Example: 07L

E.3.10.2.4 vacc

Name of attribute: **vacc**
Description: vertical accuracy of entity as a 95% LE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.10.2.5 hacc

Name of attribute:	**hacc**
Description:	horizontal accuracy of entity as a 95% CE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.10.2.6 vres

Name of attribute:	**vres**
Description:	vertical resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 9.99

E.3.10.2.7 hres

Name of attribute:	**hres**
Description:	horizontal resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	Decimal Degrees
Domain Range:	0.00000001–0.001

E.3.10.2.8 source

Name of attribute:	**source**
Description:	Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional:	No
Format:	Character
Maximal Length:	50

E.3.10.2.9 integr

Name of attribute:	**integr**
Description:	Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional:	No
Format:	Float
Domain Range:	0 – 1

E.3.10.2.10 revdate

Name of attribute:	**revdate**
Description:	Date of origination or last revision of data.
Optional:	No
Format:	Date

E.3.11 FATO

E.3.11.1 FATO Feature Definition

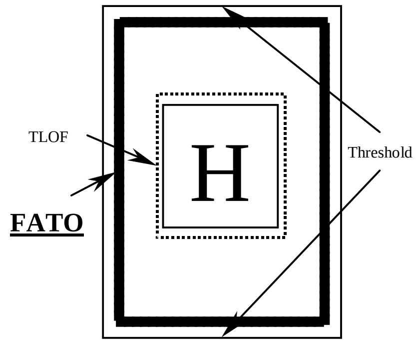


Figure E-12 **FATO Feature**

Feature Name: **FATO**
Optional: No
Description of Feature: Final approach and takeoff area (ICAO Doc 9674 WGS84-Manual, Chapter 5 Attachment C)
Geometry Type: Polygon
Derivation Method: Surveyed
Data capture rule: The outer edge of the white FATO-marking should be used to represent the FATO.

Attributes:

Name	Description
feattype	FATO feature type
arptid	ICAO aerodrome location indicator
objectid	Object identifier
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of origination or last revision of data
material	Predominant surface type

E.3.11.2 FATO Attribute Definition

E.3.11.2.1 feattype

Name of attribute: **feattype**
Description: feature type
Optional: No
Format: Character
Fixed Value: “fato”
Maximal Length: 32

E.3.11.2.2 arptid

Name of attribute:	**arptid**
Description:	ICAO aerodrome location indicator
Optional:	No
Format:	Character
Maximal Length:	5
Coding:	ICAO aerodrome designator (4-letter code) *Example: KIAD*

E.3.11.2.3 objectid

Name of attribute:	**objectid**
Description:	object identifier
Optional:	No
Format:	Character
Maximal Length:	15
Coding:	Runway-designator of both runway direction, separated by a “.“. (beginning with smaller number). *Example: 07L.25R*

E.3.11.2.4 vacc

Name of attribute:	**vacc**
Description:	vertical accuracy of entity as a 95% LE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.11.2.5 hacc

Name of attribute:	**hacc**
Description:	horizontal accuracy of entity as a 95% CE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.11.2.6 vres

Name of attribute:	**vres**
Description:	vertical resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 9.99

E.3.11.2.7 hres

Name of attribute:	**hres**
Description:	horizontal resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	Decimal Degrees
Domain Range:	0.00000001–0.001

E.3.11.2.8 source

Name of attribute: **source**
Description: Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional: No
Format: Character
Maximal Length: 50

E.3.11.2.9 integr

Name of attribute: **integr**
Description: Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional: No
Format: Float
Domain Range: 0 – 1

E.3.11.2.10 revdate

Name of attribute: **revdate**
Description: Date of origination or last revision of data.
Optional: No
Format: Date

E.3.11.2.11 material

Name of attribute: **material**
Description: Predominant surface type of FATO
Optional: No
Format: Integer
Coding:

Code	Material
1	Concrete
2	Asphalt
3	Desert/Sand
4	Bare earth
5	Snow/Ice
6	Water
7	Gras

Example for concrete: 1

E.3.12 Touchdown/Lift-off Area (TLOF)

E.3.12.1 TLOF Feature Definition

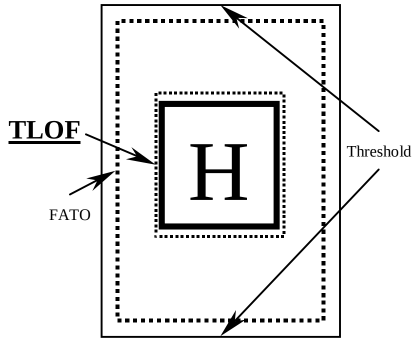


Figure E-13 TLOF Feature

Feature Name: **TLOF**
Optional: No
Description of Feature: Touchdown/liftoff area of helipad. TLOF can be missing if FATO exists (ICAO Doc 9674 WGS84-Manual, Chapter 5 Attachement C).
Geometry Type: Polygon
Derivation Method: Surveyed
Data capture rule: As specified by (ICAO Doc 9674 WGS84-Manual, Chapter 5 Attachement C). The outer edges of the white TLOF-markings should be used to represent the TLOF.
Attributes:

Name	Description
feattype	TLOF feature type
arptid	ICAO aerodrome location indicator
objectid	Object identifier
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of origination or last revision of data
material	Predominant surface type

E.3.12.2 TLOF Attribute Definition

E.3.12.2.1 feattype

Name of attribute: **feattype**
Description: feature type
Optional: No
Format: Character
Fixed Value: “tlof”
Maximal Length: 32

E.3.12.2.2 arptid

Name of attribute:	**arptid**
Description:	ICAO aerodrome location indicator
Optional:	No
Format:	Character
Maximal Length:	5
Coding:	ICAO aerodrome designator (4-letter code) *Example: KIAD*

E.3.12.2.3 objectid

Name of attribute:	**objectid**
Description:	object identifier
Optional:	No
Format:	Character
Maximal Length:	15
Coding:	Runway-designator of both runway direction, separated by a “.“. (beginning with smaller number). *Example: 07L.25R*

E.3.12.2.4 vacc

Name of attribute:	**vacc**
Description:	vertical accuracy of entity as a 95% LE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.12.2.5 hacc

Name of attribute:	**hacc**
Description:	horizontal accuracy of entity as a 95% CE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.12.2.6 vres

Name of attribute:	**vres**
Description:	vertical resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 9.99

E.3.12.2.7 hres

Name of attribute:	**hres**
Description:	horizontal resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	Decimal Degrees
Domain Range:	0.00000001–0.001

E.3.12.2.8 source

Name of attribute: **source**
Description: Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional: No
Format: Character
Maximal Length: 50

E.3.12.2.9 integr

Name of attribute: **integr**
Description: Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional: No
Format: Float
Domain Range: 0 – 1

E.3.12.2.10 revdate

Name of attribute: **revdate**
Description: Date of origination or last revision of data.
Optional: No
Format: Date

E.3.12.2.11 material

Name of attribute: **material**
Description: Predominant surface type of TLOF
Optional: No
Format: Integer
Coding:

Code	Material
1	Concrete
2	Asphalt
3	Desert/Sand
4	Bare earth
5	Snow/Ice
6	Water
7	Gras

Example for concrete: 1

E.3.13 Helipad Threshold

E.3.13.1 Helipad Threshold Feature Definition

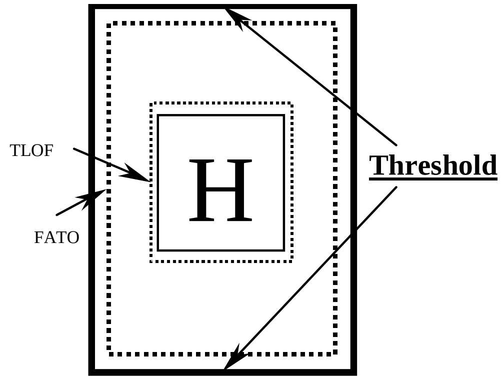


Figure E-14 Helipad Threshold Feature

Feature Name: **helipad threshold**
Optional: No
Description of Feature: Threshold of a helipad.
Geometry Type: Point
Derivation Method: Surveyed
Data capture rule: Helipad threshold should be located according ICAO Doc 9674 WGS84-Manual, Chapter 5 Attachement C. Helipad-thresholds should be surveyed in all 3 dimensions.

Attributes:

Name	Description
Feattype	Helipad Threshold feature type
Arptid	ICAO aerodrome location indicator
Objectid	Object identifier
Vacc	Vertical accuracy (as a 95% LE)
Hacc	Horizontal accuracy (as a 95% CE)
Vres	Vertical resolution of coordinates defining the feature
Hres	Horizontal resolution of coordinates defining the feature
Source	Name of entity or organization that supplied data
Integr	Data integrity
Revdate	Date of origination or last revision of data
Status	Status of corresponding FATO/TLOF
Ellipse	Ellipsoidal elevation of helipad threshold

E.3.13.2 Helipad Threshold Attribute Definition

E.3.13.2.1 feattype

Name of attribute: **feattype**
Description: feature type
Optional: No
Format: Character
Fixed Value: “helipad threshold”
Maximal Length: 32

E.3.13.2.2 arptid

Name of attribute: **arptid**
Description: ICAO aerodrome location indicator
Optional: No
Format: Character
Maximal Length: 5
Coding: ICAO aerodrome designator (4-letter code)
Example: KIAD

E.3.13.2.3 objectid

Name of attribute: **objectid**
Description: object identifier
Optional: No
Format: Character
Maximal Length: 15
Coding: Runway-designator of corresponding runway direction.
Example: 07L

E.3.13.2.4 vacc

Name of attribute: **vacc**
Description: vertical accuracy of entity as a 95% LE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.13.2.5 hacc

Name of attribute: **hacc**
Description: horizontal accuracy of entity as a 95% CE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.13.2.6 vres

Name of attribute: **vres**
Description: vertical resolution of coordinates defining the feature
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 9.99

E.3.13.2.7 hres

Name of attribute:	**hres**
Description:	horizontal resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	Decimal Degrees
Domain Range:	0.00000001–0.001

E.3.13.2.8 source

Name of attribute:	**source**
Description:	Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional:	No
Format:	Character
Maximal Length:	50

E.3.13.2.9 integr

Name of attribute:	**integr**
Description:	Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional:	No
Format:	Float
Domain Range:	0 – 1

E.3.13.2.10 revdate

Name of attribute:	**revdate**
Description:	Date of origination or last revision of data.
Optional:	No
Format:	Date

E.3.13.2.11 status

Name of Attribute:	**status**
Description:	Permanent state of corresponding TLOF/FATO (exceeding AMDB update cycle): open or closed.
Optional:	No
Format:	Bool
Coding:	open (1) or closed (0)

E.3.13.2.12 ellipse

Name of Attribute:	**ellipse**
Description:	Ellipsoidal elevation of helipad threshold.
Optional:	No
Derivation Method:	surveyed
Format:	Float
Units of Measurement:	meters
Domain Range:	-500.00 – 9000.00

E.3.14 Taxiway

E.3.14.1 Taxiway Segment Feature Definition

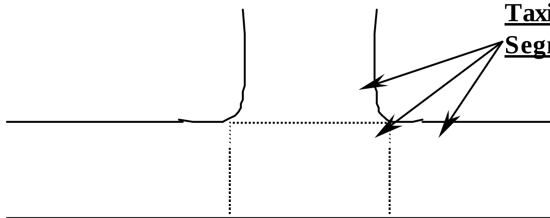


Figure E-15 **Taxiway Segment Feature**

Feature Name:	**taxiway segment**
Optional:	No
Description of Feature:	The taxiway segment features are used to represents taxiway, apron taxiway, rapid exit taxiway, taxiway intersection, and aircraft stand taxilane surface (see definition: ICAO Annex 14, Chapter 1.1).
Geometry Type:	Polygon
Derivation Method:	Surveyed
Data capture rule:	The taxiway segment features consist of multiple polygons. Each polygon represents a segment of a single taxiway, apron taxiway, rapid exit taxiway, taxiway intersection, and aircraft stand taxilane surface. A single taxiway is a designated taxi-route identified by the same name. The intersection of two taxiways should be captured as an individual object. The taxiway segment polygon should be limited by the outer side of the taxiway edge marking.

Attributes:

Name	Description
feattype	Taxiway segment feature type
arptid	ICAO aerodrome location indicator
objectid	Object identifier
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of origination or last revision of data
material	Predominant surface type of the runway
pcn	Pavement classification number (pcn) of taxiway

E.3.14.2 Taxiway Segment Attribute Definition

E.3.14.2.1 feattype

Name of attribute: **feattype**
Description: feature type
Optional: No
Format: Character
Fixed Value: “taxiway”
Maximal Length: 32

E.3.14.2.2 arptid

Name of attribute: **arptid**
Description: ICAO aerodrome location indicator
Optional: No
Format: Character
Maximal Length: 5
Coding: ICAO aerodrome designator (4-letter code)
Example: KIAD

E.3.14.2.3 objectid

Name of attribute: **objectid**
Description: object identifier
Optional: No
Format: Character
Maximal Length: 15
Coding: Taxiway segment name. The name should be identical to the corresponding taxiway name. Multiple taxiway segments can have the same name. If two or more taxiways intersect the taxiway segment intersection will be named after the predominant taxiway. If two taxiways on the same level intersect the segment can be named arbitrary after one of the taxiways.

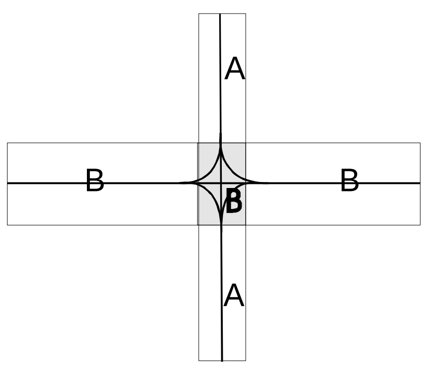


Figure E-16 Taxiway Segment Identification Example

E.3.14.2.4 vacc

Name of attribute: **vacc**
Description: vertical accuracy of entity as a 95% LE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.14.2.5 hacc

Name of attribute:	**hacc**
Description:	horizontal accuracy of entity as a 95% CE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.14.2.6 vres

Name of attribute:	**vres**
Description:	vertical resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 9.99

E.3.14.2.7 hres

Name of attribute:	**hres**
Description:	horizontal resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	Decimal Degrees
Domain Range:	0.00000001–0.001

E.3.14.2.8 source

Name of attribute:	**source**
Description:	Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional:	No
Format:	Character
Maximal Length:	50

E.3.14.2.9 integr

Name of attribute:	**integr**
Description:	Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional:	No
Format:	Float
Domain Range:	0 – 1

E.3.14.2.10 revdate

Name of attribute:	**revdate**
Description:	Date of origination or last revision of data.
Optional:	No
Format:	Date

E.3.14.2.11 material

Name of attribute: **material**
Description: Predominant surface type of taxiway
Optional: No
Format: Integer
Coding:

Code	Material
1	Concrete
2	Asphalt
3	Desert/Sand
4	Bare earth
5	Snow/Ice
6	Water
7	Gras

Example for concrete: 1

E.3.14.2.12 pcn

Name of attribute: **pcn**
Description: Pavement classification number (pcn) of taxiway.
Optional: No
Format: Integer
Coding: Aircraft classification number – pavement classification number ACN-PCN. The format is specified in ICAO Annex 14, Chapter 2.6
Example: PCN80/R/B/W/T

E.3.15 Taxiway Shoulder

E.3.15.1 Taxiway Shoulder Feature Definition

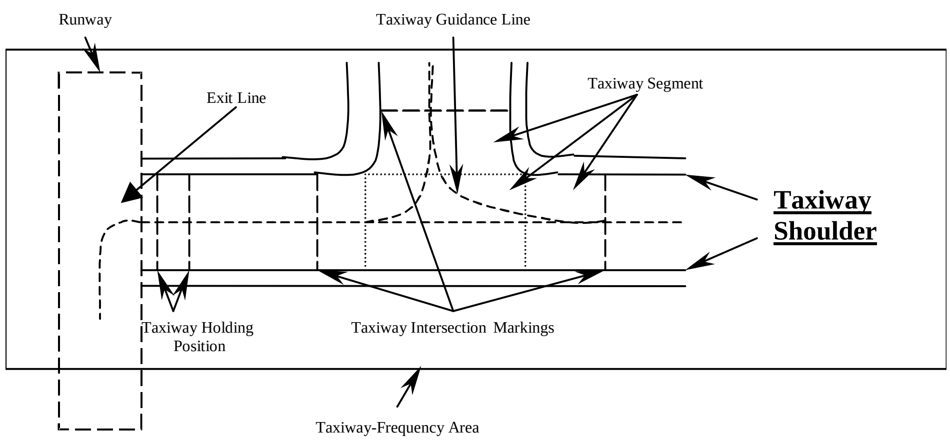


Figure E-17 Taxiway Shoulder Feature

Feature Name: **taxiway shoulder**
Optional: No
Description of Feature: Shoulder of a taxiway (see definition: ICAO Annex 14, Chapter 1.1).
Geometry Type: Polygon.
Derivation Method: Surveyed
Data capture rule: Part of taxiway that is separated from the main taxiway body by the taxiway edge marking. The taxiway shoulder polygon should exclude the taxiway edge marking. It can consist of multiple polygons forming the overall taxiway shoulder.
Attributes:

Name	Description
feattype	Taxiway Shoulder feature type
arptid	ICAO aerodrome location indicator
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of origination or last revision of data
material	Predominant surface type
status	Permanent state of taxiway shoulder

E.3.15.2 Taxiway Shoulder Attribute Definition

E.3.15.2.1 feattype

Name of attribute: **feattype**
Description: feature type
Optional: No
Format: Character
Fixed Value: “taxiway shoulder”
Maximal Length: 32

E.3.15.2.2 arptid

Name of attribute: **arptid**
Description: ICAO aerodrome location indicator
Optional: No
Format: Character
Maximal Length: 5
Coding: ICAO aerodrome designator (4-letter code)
Example: KIAD

E.3.15.2.3 vacc

Name of attribute: **vacc**
Description: vertical accuracy of entity as a 95% LE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.15.2.4 hacc

Name of attribute: **hacc**
Description: horizontal accuracy of entity as a 95% CE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.15.2.5 vres

Name of attribute: **vres**
Description: vertical resolution of coordinates defining the feature
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00–9.99

E.3.15.2.6 hres

Name of attribute: **hres**
Description: horizontal resolution of coordinates defining the feature
Optional: No
Format: Float
Units of Measurement: Decimal Degrees
Domain Range: 0.00000001-0.001

E.3.15.2.7 source

Name of attribute: **source**
Description: Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional: No
Format: Character
Maximal Length: 50

E.3.15.2.8 integr

Name of attribute: **integr**
Description: Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional: No
Format: Float
Domain Range: 0 – 1

E.3.15.2.9 revdate

Name of attribute: **revdate**
Description: Date of origination or last revision of data.
Optional: No
Format: Date

E.3.15.2.10 material

Name of attribute: **material**
Description: Predominant surface type of Taxiway Shoulder
Optional: No
Format: Integer
Coding:

Code	Material
1	Concrete
2	Asphalt
3	Desert/Sand
4	Bare earth
5	Snow/Ice
6	Water
7	Gras

Example for concrete: 1

E.3.15.2.11 status

Name of Attribute: **status**
Description: Permanent state of taxiway shoulder: usable or unusable.
Optional: No
Format: Bool
Coding: usable (1) or unusable (0)

E.3.16 Taxiway Guidance Line

E.3.16.1 Taxiway Guidance Line Definition

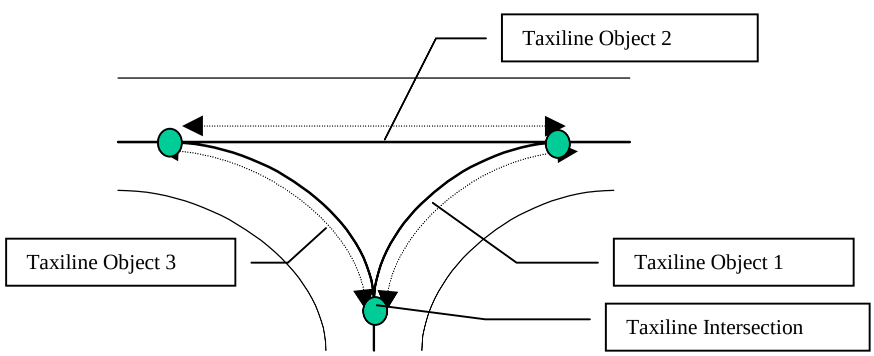


Figure E-18 Taxiway Guidance Line Feature

Feature Name: **taxiway guidance line**
Optional: No
Description of Feature: Guidance line painted on a taxiway (see definition: ICAO Annex 14, Chapter 5.2.8) not including rapid exit lines and aircraft parking stand taxilines.
Geometry Type: Line
Derivation Method: Surveyed
Data capture rule: Each taxiline feature should be captured as a straight or curved line between two taxiline intersections. To ensure connectivity connecting taxiway guidance line features should share the same start- and endpoint.
Attributes:

Name	Description
feattype	Taxiway Guidance Line feature type
arptid	ICAO aerodrome location indicator
objectid	Object identifier
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of origination or last revision of data
Status	Status of corresponding taxiway
wingspan	Maximal wingspan allowed on taxiway
maxspeed	Maximal allowed speed on taxiway
direc	Directionality of taxiway

E.3.16.2 Taxiway Guidance Line Attribute Definition

E.3.16.2.1 feattype

Name of attribute: **feattype**
Description: feature type
Optional: No
Format: Character
Fixed Value: “taxiway guidance line”
Maximal Length: 32

E.3.16.2.2 arptid

Name of attribute: **arptid**
Description: ICAO aerodrome location indicator
Optional: No
Format: Character
Maximal Length: 5
Coding: ICAO aerodrome designator (4-letter code)
Example: KIAD

E.3.16.2.3 objectid

Name of attribute:	**objectid**
Description:	object identifier
Optional:	No
Format:	Character
Maximal Length:	15
Coding:	Taxilines should be assigned with the underlying taxiway segment objectid. If two or more taxiway segments are covered by the same continuous taxiline the name of the predominatly covered taxiway segment should be used as taxiway segment name for the objectid. If the line is on a rapid exit taxiway the name of the adjacent taxiway is used as a segment name.

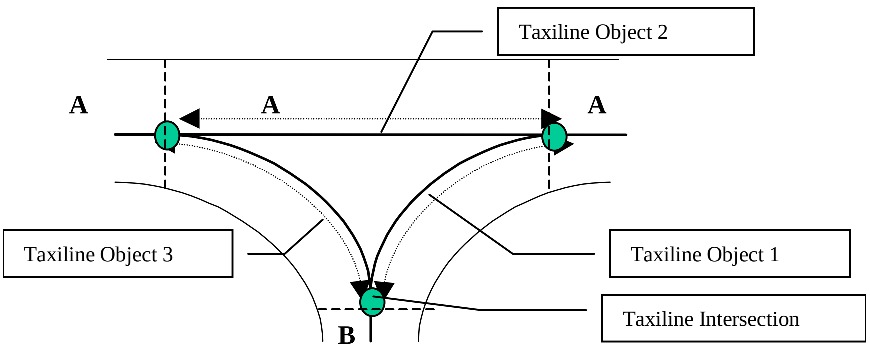


Figure E-19 Taxiway Guidance Line Identification Example

E.3.16.2.4 vacc

Name of attribute:	**vacc**
Description:	vertical accuracy of entity as a 95% LE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.16.2.5 hacc

Name of attribute:	**hacc**
Description:	horizontal accuracy of entity as a 95% CE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.16.2.6 vres

Name of attribute:	**vres**
Description:	vertical resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00–9.99

E.3.16.2.7 hres

Name of attribute:	**hres**
Description:	horizontal resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	Decimal Degrees
Domain Range:	0.00000001–0.001

E.3.16.2.8 source

Name of attribute:	**source**
Description:	Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional:	No
Format:	Character
Maximal Length:	50

E.3.16.2.9 integr

Name of attribute:	**integr**
Description:	Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional:	No
Format:	Float
Domain Range:	0 – 1

E.3.16.2.10 revdate

Name of attribute:	**revdate**
Description:	Date of origination or last revision of data.
Optional:	No
Format:	Date

E.3.16.2.11 status

Name of Attribute:	**status**
Description:	Status of corresponding Taxiway : open or closed.
Optional:	No
Format:	Bool
Coding:	open (1) or closed (0)

E.3.16.2.12 wingspan

Name of attribute:	**wingspan**
Description:	Max. Wingspan on taxiway
Optional:	Yes
Format:	Float
Units of Measurement:	meters
Domain Range:	0-80

E.3.16.2.13 maxspeed

Name of attribute: **maxspeed**
Description: Max. Speed on taxiway
Optional: Yes
Format: Float
Units of Measurement: knots
Domain Range: 0-50

E.3.16.2.14 direc

Name of attribute: **direc**
Description: Directionality of a corresponding taxiway. Taxiway can be one-way or bi-directional.
Optional: No
Format: Integer
Coding: Code describing the directionality of corresponding taxiway.

Code	Value
0	Bidirectional
1	One way from start-to-endpoint of taxiline *(Example: 1 to 5)*
2	One way from end-to-startpoint of taxiline *(Example: 5 to 1)*

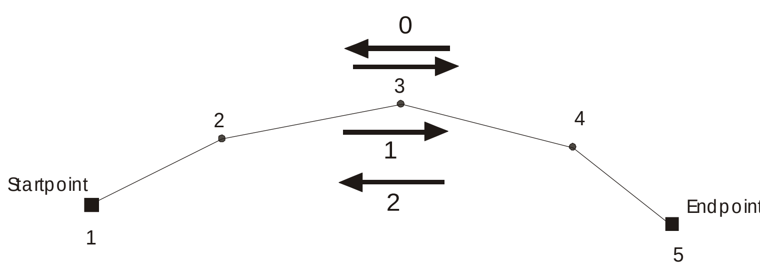


Figure E-20 Taxiway Guidance Line Directionality Coding

E.3.17 Taxiway Intersection Marking

E.3.17.1 Taxiway Intersection Marking Feature Definition

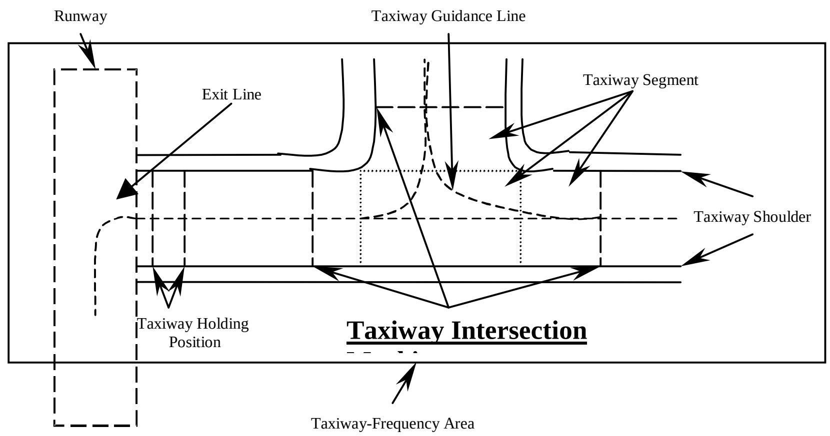


Figure E-21 Taxiway Intersection Marking Feature

Feature Name: **taxiway intersection marking**
Optional: No
Description of Feature: Taxi Intersection Marking (see definition: ICAO Annex 14, Chapter 5.2.10).
Geometry Type: Line
Derivation Method: Surveyed
Data capture rule: The line should be located in the center of the painted ground marking.

Attributes:

Name	Description
feattype	Taxiway Intersection Marking feature type
arptid	ICAO aerodrome location indicator
objectid	Object identifier
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of origination or last revision of data

E.3.17.2 Taxiway Intersection Marking Attribute Definition

E.3.17.2.1 feattype

Name of attribute: **feattype**
Description: feature type
Optional: No
Format: Character
Fixed Value: “taxiway intersection marking”
Maximal Length: 32

E.3.17.2.2 arptid

Name of attribute:	**arptid**
Description:	ICAO aerodrome location indicator
Optional:	No
Format:	Character
Maximal Length:	5
Coding:	ICAO aerodrome designator (4-letter code) *Example: KIAD*

E.3.17.2.3 objectid

Name of attribute:	**objectid**
Description:	object identifier
Optional:	No
Format:	Character
Maximal Length:	15
Coding:	Designator of corresponding Taxiway. *Example: A*

E.3.17.2.4 vacc

Name of attribute:	**vacc**
Description:	vertical accuracy of entity as a 95% LE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.17.2.5 hacc

Name of attribute:	**hacc**
Description:	horizontal accuracy of entity as a 95% CE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.17.2.6 vres

Name of attribute:	**vres**
Description:	vertical resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00–9.99

E.3.17.2.7 hres

Name of attribute:	**hres**
Description:	horizontal resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	Decimal Degrees
Domain Range:	0.00000001–0.001

E.3.17.2.8 source

Name of attribute:	**source**
Description:	Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional:	No
Format:	Character
Maximal Length:	50

E.3.17.2.9 integr

Name of attribute:	**integr**
Description:	Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional:	No
Format:	Float
Domain Range:	0 – 1

E.3.17.2.10 revdate

Name of attribute:	**revdate**
Description:	Date of origination or last revision of data.
Optional:	No
Format:	Date

E.3.18 Taxiway Holding Position (Stopbar)

E.3.18.1 Taxiway Holding Position Feature Definition

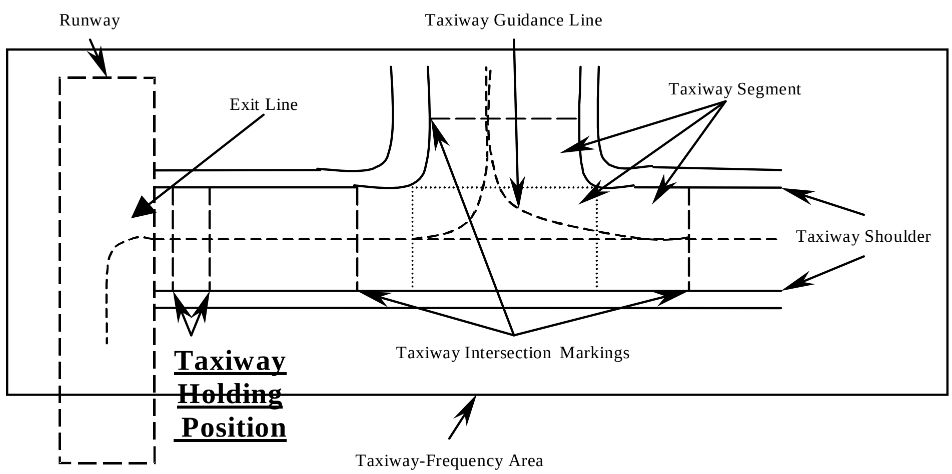


Figure E-22 Taxiway Holding Position Feature

Feature Name: **taxiway holding position**
Optional: No
Description of Feature: Taxiway holding position (see definition: ICAO Annex 14, Chapter 5.2.9/5.3.17).
Geometry Type: Line
Derivation Method: Surveyed
Data capture rule: The line should be located in the outer edge of the painted ground marking (stop bar) away from the corresponding runway.
Attributes:

Name	Description
feattype	Taxiway Holding Position feature type
arptid	ICAO aerodrome location indicator
objectid	Object identifier
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of origination or last revision of data
status	Permanent state of Taxiway Holding Position
cat	Low visibility operation category of stopbar
rwyid	ID of corresponding runway

E.3.18.2 Taxiway Intersection Marking Attribute Definition

E.3.18.2.1 feattype

Name of attribute: **feattype**
Description: feature type
Optional: No
Format: Character
Fixed Value: “taxiway holding position”
Maximal Length: 32

E.3.18.2.2 arptid

Name of attribute: **arptid**
Description: ICAO aerodrome location indicator
Optional: No
Format: Character
Maximal Length: 5
Coding: ICAO aerodrome designator (4-letter code)
Example: KIAD

E.3.18.2.3 objectid

Name of attribute: **objectid**
Description: object identifier
Optional: No
Format: Character
Maximal Length: 15
Coding: Designator of corresponding taxiway.
Example: A

E.3.18.2.4 vacc

Name of attribute: **vacc**
Description: vertical accuracy of entity as a 95% LE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.18.2.5 hacc

Name of attribute: **hacc**
Description: horizontal accuracy of entity as a 95% CE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.18.2.6 vres

Name of attribute: **vres**
Description: vertical resolution of coordinates defining the feature
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00–9.99

E.3.18.2.7 hres

Name of attribute: **hres**
Description: horizontal resolution of coordinates defining the feature
Optional: No
Format: Float
Units of Measurement: Decimal Degrees
Domain Range: 0.00000001– 0.001

E.3.18.2.8 source

Name of attribute: **source**
Description: Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional: No
Format: Character
Maximal Length: 50

E.3.18.2.9 integr

Name of attribute: **integr**
Description: Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional: No
Format: Float
Domain Range: 0 – 1

E.3.18.2.10 revdate

Name of attribute: **revdate**
Description: Date of origination or last revision of data.
Optional: No
Format: Date

E.3.18.2.11 status

Name of Attribute: **status**
Description: Permanent state of Taxiway Holding Position: operativ or inoperative.
Optional: No
Format: Bool
Coding: operativ (1) or inoperativ (0)

E.3.18.2.12 cat

Name of Attribute: **cat**
Description: Low visibility operation category of stopbar.
Optional: No
Format: Integer
Coding: Code describing the Low visibility operation category of stopbar.

Code	Value ICAO Annex 14, Chapter 5.3.4
0	No low visibility operation supported
1	Supports ILS CAT I low visibility operation
2	Supports ILS CATII/III low visibility operations

E.3.18.2.13 rwyid

Name of attribute: **rwyid**
Description: ID of corresponding runway
Optional: No
Format: Character
Maximal Length: 15
Coding: Corresponding runway-designator of both runway direction, separated by a “.“. (beginning with smaller number). *Example: 07L.25R*

E.3.19 Exit Line

E.3.19.1 Exit Line Feature Definition

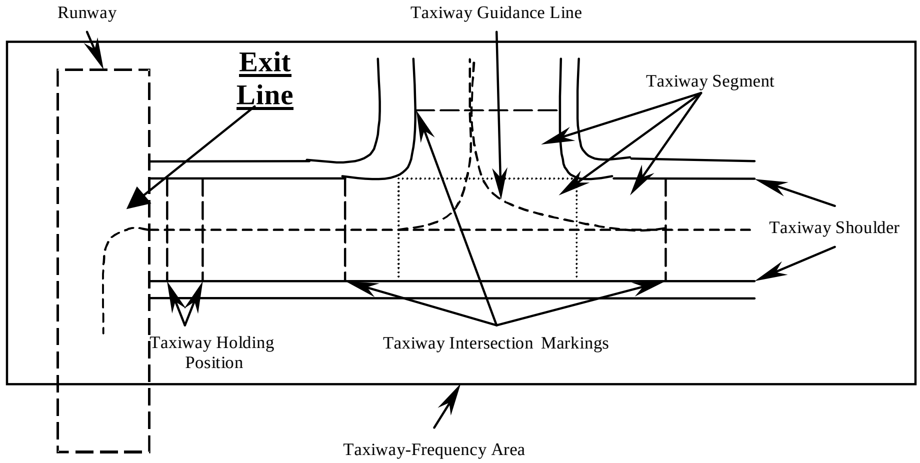


Figure E-23 Exit Line Feature

Feature Name:	**exit line**
Optional:	No
Description of Feature:	Exit line painted on the runway.
Geometry Type:	Line
Derivation Method:	Surveyed
Data capture rule:	The exit line should end at the first intersection of the exit line with any other taxiline. The endpoint of the exit line should be the startpoint of a connecting taxiline.

Attributes:

Name	Description
feattype	Exit Line feature type
arptid	ICAO aerodrome location indicator
objectid	Object identifier
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of origination or last revision of data
Status	Permanent state of Exit Line: operativ (1) or inoperativ(0).
direc	Directionality of corresponding taxiway

E.3.19.2 Exit Line Attribute Definition

E.3.19.2.1 feattype

Name of attribute:	**feattype**
Description:	feature type
Optional:	No
Format:	Character
Fixed Value:	“exit line”
Maximal Length:	32

E.3.19.2.2 arptid

Name of attribute:	**arptid**
Description:	ICAO aerodrome location indicator
Optional:	No
Format:	Character
Maximal Length:	5
Coding:	ICAO aerodrome designator (4-letter code) *Example: KIAD*

E.3.19.2.3 objectid

Name of attribute:	**objectid**
Description:	object identifier
Optional:	No
Format:	Character
Maximal Length:	15
Coding:	Exitlines should be assigned with the adjacent taxiway segment objectid. *Example: A*

E.3.19.2.4 vacc

Name of attribute:	**vacc**
Description:	vertical accuracy of entity as a 95% LE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.19.2.5 hacc

Name of attribute:	**hacc**
Description:	horizontal accuracy of entity as a 95% CE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.19.2.6 vres

Name of attribute:	**vres**
Description:	vertical resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00–9.99

E.3.19.2.7 hres

Name of attribute:	**hres**
Description:	horizontal resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	Decimal Degrees
Domain Range:	0.00000001-0.001

E.3.19.2.8 source

Name of attribute:	**source**
Description:	Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional:	No
Format:	Character
Maximal Length:	50

E.3.19.2.9 integr

Name of attribute:	**integr**
Description:	Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional:	No
Format:	Float
Domain Range:	0 – 1

E.3.19.2.10 revdate

Name of attribute:	**revdate**
Description:	Date of origination or last revision of data.
Optional:	No
Format:	Date

E.3.19.2.11 status

Name of Attribute:	**status**
Description:	Status of corresponding Taxiway : open or closed.
Optional:	No
Format:	Bool
Coding:	open (1) or closed (0)

E.3.19.2.12 direc

Name of attribute: **direc**
Description: Directionality of corresponding taxiway.
Optional: No
Format: Integer
Coding: Code describing the directionality of taxiline.

Code	Value
0	Bidirectional
1	One way from start-to-endpoint of line *(Example: 1 to 5)*
2	One way from end-to-startpoint of line *(Example: 5 to 1)*

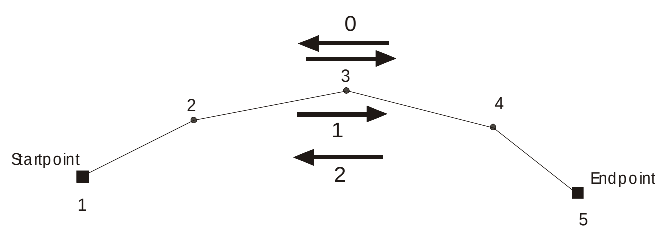


Figure E-24 Runway Exit Line Directionality Coding

E.3.20 Frequency Area

E.3.20.1 Frequency Area Feature Definition

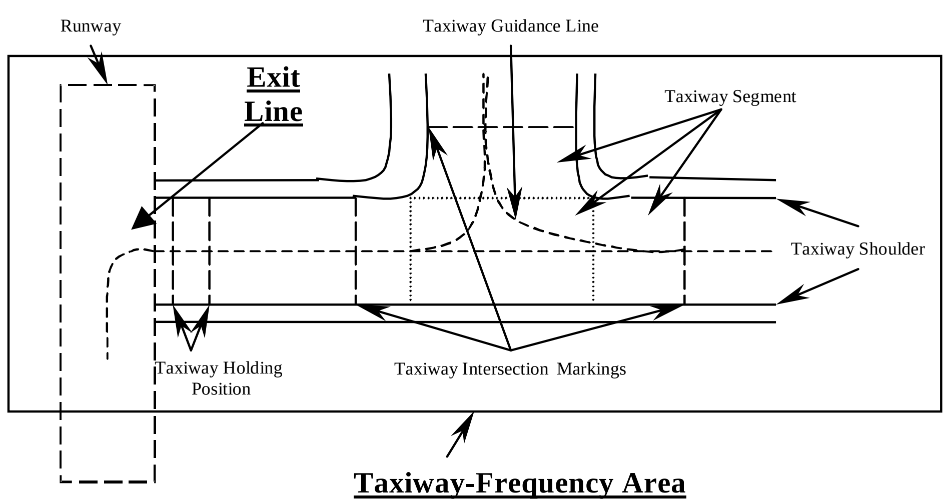


Figure E-25 Frequency Area Feature

Feature Name: **frequency area**
Optional: No
Description of Feature: Area specifying the designated part of the surface movement area where a specific frequency is required by ATC or ground control.
Geometry Type: Polygon
Derivation Method: Calculated
Data capture rule: The frequency area polygon should not exceed a buffer of 50m of the surface movement area.
Attributes:

Name	Description
feattype	Frequency area feature type
arptid	ICAO aerodrome location indicator
hacc	Horizontal accuracy (as a 95% CE)
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of origination or last revision of data
frq	Primary frequency to use
station	Service or Station assigned to primary frequency (e.g., ATC Tower, Ground Control)

E.3.20.2 Frequency Area Attribute Definition

E.3.20.2.1 feattype

Name of attribute: **feattype**
Description: feature type
Optional: No
Format: Character
Fixed Value: “frequency area”
Maximal Length: 32

E.3.20.2.2 arptid

Name of attribute: **arptid**
Description: ICAO aerodrome location indicator
Optional: No
Format: Character
Maximal Length: 5
Coding: ICAO aerodrome designator (4-letter code)
Example: KIAD

E.3.20.2.3 hacc

Name of attribute: **hacc**
Description: horizontal accuracy of entity as a 95% CE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.20.2.4 hres

Name of attribute: **hres**
Description: horizontal resolution of coordinates defining the feature
Optional: No
Format: Float
Units of Measurement: Decimal Degrees
Domain Range: 0.00000001–0.001

E.3.20.2.5 source

Name of attribute: **source**
Description: Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional: No
Format: Character
Maximal Length: 50

E.3.20.2.6 integr

Name of attribute: **integr**
Description: Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional: No
Format: Float
Domain Range: 0 – 1

E.3.20.2.7 revdate

Name of attribute: **revdate**
Description: Date of origination or last revision of data.
Optional: No
Format: Date

E.3.20.2.8 frq

Name of Attribute: **frq**
Description: Primary frequency used on frequency area
Optional: No
Format: Float
Units of Measurement: MHZ
Domain Range: 117.975 – 136.000

E.3.20.2.9 station

Name of Attribute: **station**
Description: Service or Station assigned to primary frequency (e.g., ATC Tower, Ground Control)
Optional: No
Format: Character
Maximal Length: 30

E.3.21 Apron

E.3.21.1 Apron Feature Definition

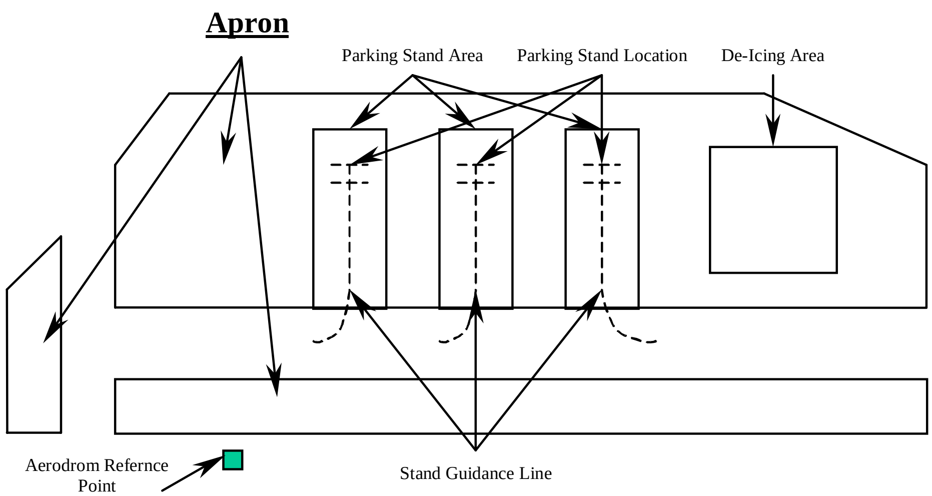


Figure E-26 Apron Feature

Feature Name:	**apron**
Optional:	No
Description of Feature:	Aircraft accessible apron area that is not a aircraft stand, a aircraft stand taxilane, or an apron taxiway.
Geometry Type:	Polygon
Derivation Method:	Surveyed
Data capture rule:	The apron feature may consist of multiple polygons. To avoid overlapping no apron polygon should cover aircraft stands, aircraft stand taxilanes, and deicing areas.

Attributes:

Name	Description
feattype	Apron feature type
arptid	ICAO aerodrome location indicator
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of origination or last revision of data
material	Predominant surface type of the runway
pcn	Pavement classification number of Apron
status	Permanent state of apron

E.3.21.2 Apron Attribute Definition

E.3.21.2.1 feattype

Name of attribute:	**feattype**
Description:	feature type
Optional:	No
Format:	Character
Fixed Value:	“apron”
Maximal Length:	32

E.3.21.2.2 arptid

Name of attribute:	**arptid**
Description:	ICAO aerodrome location indicator
Optional:	No
Format:	Character
Maximal Length:	5
Coding:	ICAO aerodrome designator (4-letter code) *Example: KIAD*

E.3.21.2.3 vacc

Name of attribute:	**vacc**
Description:	vertical accuracy of entity as a 95% LE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.21.2.4 hacc

Name of attribute:	**hacc**
Description:	horizontal accuracy of entity as a 95% CE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.21.2.5 vres

Name of attribute:	**vres**
Description:	vertical resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00–9.99

E.3.21.2.6 hres

Name of attribute:	**hres**
Description:	horizontal resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	Decimal Degrees
Domain Range:	0.00000001–0.001

E.3.21.2.7 source

Name of attribute: **source**
Description: Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional: No
Format: Character
Maximal Length: 50

E.3.21.2.8 integr

Name of attribute: **integr**
Description: Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional: No
Format: Float
Domain Range: 0 – 1

E.3.21.2.9 revdate

Name of attribute: **revdate**
Description: Date of origination or last revision of data.
Optional: No
Format: Date

E.3.21.2.10 material

Name of attribute: **material**
Description: Predominant Predominant surface type of apron
Optional: No
Format: Integer
Coding:

Code	Material
1	Concrete grooved
2	Asphalt grooved
3	Desert/Sand
4	Bare earth
5	Snow/Ice
6	Water
7	Gras

Example for concrete: 1

E.3.21.2.11 pcn

Name of attribute: **pcn**
Description: Pavement classification number (pcn) of apron.
Optional: No
Format: Integer
Coding: Aircraft classification number – pavement classification number ACN-PCN. The format is specified in ICAO Annex 14, Chapter 2.6
Example: PCN80/R/B/W/T

E.3.21.2.12 status

Name of Attribute: **status**
Description: Permanent state of apron (exceeding AMDB update cycle): open or closed.
Optional: No
Format: Bool
Coding: open (1) or closed (0)

E.3.22 Stand Guidance Taxiline

E.3.22.1 Stand Guidance Taxiline Feature Definition

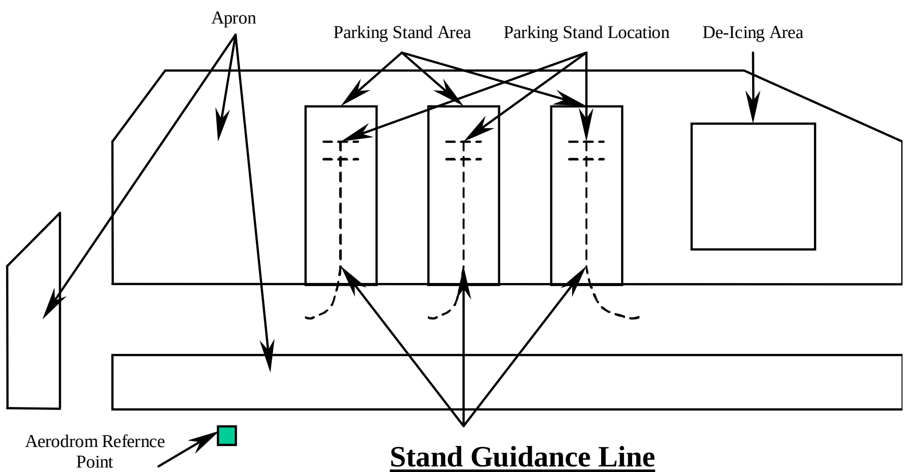


Figure E-27 **Stand Guidance Line Feature**

Feature Name: **stand guidance taxiline**
Optional: No
Description of Feature: All painted taxilines covering an parking stand area are regarded stand guidancelines. There may be several stand guidance taxilines covering an aircraft stand to accomodate different aircraft types
Geometry Type: Line
Derivation Method: Surveyed
Data capture rule: There may be several stand guidance taxilines covering an aircraft stand to accomodate different aircraft types.To ensure connectivity, the startpoint of a stand guidance taxiline should be the endpoint of the connecting taxiway guidance line (only if applicable). The endpoint of the stand guidance line should be coincident with a parking stand location.

Attributes:

Name	Description
feattype	Stand Guidance Taxiline feature type
arptid	ICAO aerodrome location indicator
objectid	Object identifier
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of origination or last revision of data
status	Permanent state of corresponding Parking Stand Area
direc	Directionality of Stand Guidance Taxiline
wingspan	Maximal wingspan allowed on corresponding parking stand

E.3.22.2 Stand Guidance Taxiline Attribute Definition

E.3.22.2.1 feattype

Name of attribute: **feattype**
Description: feature type
Optional: No
Format: Character
Fixed Value: “stand guidance taxiline”
Maximal Length: 32

E.3.22.2.2 arptid

Name of attribute: **arptid**
Description: ICAO aerodrome location indicator
Optional: No
Format: Character
Maximal Length: 5
Coding: ICAO aerodrome designator (4-letter code)
Example: KIAD

E.3.22.2.3 objectid

Name of attribute: **objectid**
Description: object identifier
Optional: No
Format: Character
Maximal Length: 15
Coding: Stand Guidance Taxiline should be assigned with the adjacent parking stand area feature objectid.
Example: V123

E.3.22.2.4 vacc

Name of attribute: **vacc**
Description: vertical accuracy of entity as a 95% LE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.22.2.5 hacc

Name of attribute: **hacc**
Description: horizontal accuracy of entity as a 95% CE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.22.2.6 vres

Name of attribute: **vres**
Description: vertical resolution of coordinates defining the feature
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00–9.99

E.3.22.2.7 hres

Name of attribute: **hres**
Description: horizontal resolution of coordinates defining the feature
Optional: No
Format: Float
Units of Measurement: Decimal Degrees
Domain Range: 0.00000001–0.001

E.3.22.2.8 source

Name of attribute: **source**
Description: Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional: No
Format: Character
Maximal Length: 50

E.3.22.2.9 integr

Name of attribute: **integr**
Description: Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional: No
Format: Float
Domain Range: 0 – 1

E.3.22.2.10 revdate

Name of attribute: **revdate**
Description: Date of origination or last revision of data.
Optional: No
Format: Date

E.3.22.2.11 status

Name of Attribute: **status**
Description: Permanent Status of corresponding Aircraft Parking Stand Area: open or closed.
Optional: No
Format: Bool
Coding: open (1) or closed (0)

E.3.22.2.12 direc

Name of attribute: **direc**
Description: Directionality of parking stand guidanceline
Optional: No
Format: Integer
Coding: Directionality of Stand Guidance Taxiline.

Code	Value
0	Bidirectional
1	One way from start-to-endpoint of line *(Example: 1 to 5)*
2	One way from end-to-startpoint of line *(Example: 5 to 1)*

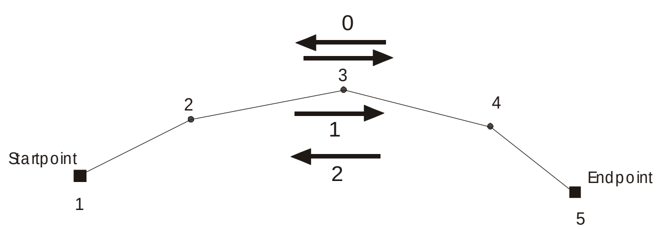


Figure E-28 Stand Guidance Line Directionality Coding

E.3.22.2.13 wingspan

Name of attribute: **wingspan**
Description: Maximal wingspan allowed on corresponding parking stand
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0-80

E.3.23 Parking Stand Location

E.3.23.1 Parking Stand Location Feature Definition

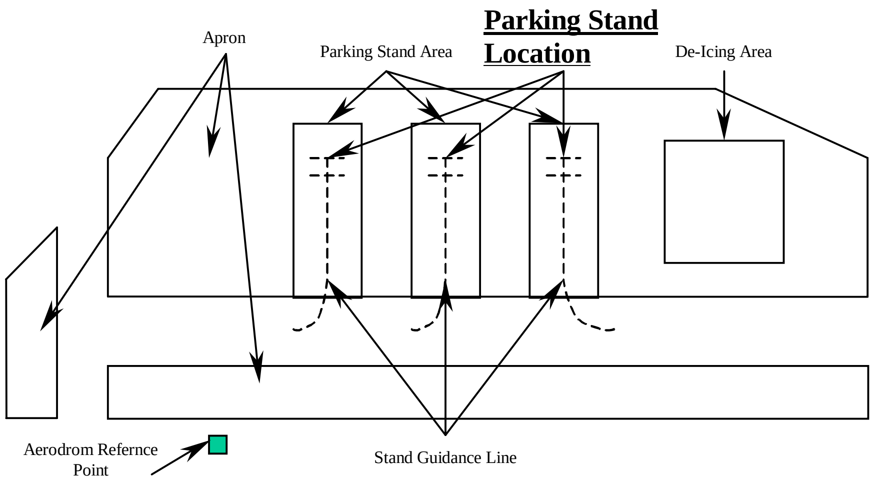


Figure E-29 **Parking Stand Feature**

Feature Name: **parking stand location**
Optional: No
Description of Feature: The aircraft stand location defines the outermostlocation to where a parking stand area can accomodate a specific aircraft type.
Geometry Type: Point
Derivation Method: Surveyed
Data capture rule: Typically, the aircraft stand location is located on the stand guidance taxiline and marked by a yellow cross-bar. There may be multiple parking stand locations corresponding to on parking stand area to accomodate different aircraft types (e.g., for B747, AB340, etc).

Attributes:

Name	Description
feattype	Parking Stand Location feature type
arptid	ICAO aerodrome location indicator
objectid	Object identifier
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of origination or last revision of data
acn	Aircraft type according ICAO-ACN (Aircraft classification number)

E.3.23.2 Parking Stand Location Feature Attribute Definition

E.3.23.2.1 feattype

Name of attribute:	**feattype**
Description:	feature type
Optional:	No
Format:	Character
Fixed Value:	“parking stand location”
Maximal Length:	32

E.3.23.2.2 arptid

Name of attribute:	**arptid**
Description:	ICAO aerodrome location indicator
Optional:	No
Format:	Character
Maximal Length:	5
Coding:	ICAO aerodrome designator (4-letter code) *Example: KIAD*

E.3.23.2.3 objectid

Name of attribute:	**objectid**
Description:	object identifier
Optional:	No
Format:	Character
Maximal Length:	15
Coding:	Parking stand Location should be assigned with the adjacent Parking stand area feature objectid. *Example: V123*

E.3.23.2.4 vacc

Name of attribute:	**vacc**
Description:	vertical accuracy of entity as a 95% LE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.23.2.5 hacc

Name of attribute:	**hacc**
Description:	horizontal accuracy of entity as a 95% CE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.23.2.6 vres

Name of attribute:	**vres**
Description:	vertical resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00–9.99

E.3.23.2.7 hres

Name of attribute:	**hres**
Description:	horizontal resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	Decimal Degrees
Domain Range:	0.00000001–0.001

E.3.23.2.8 source

Name of attribute:	**source**
Description:	Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional:	No
Format:	Character
Maximal Length:	50

E.3.23.2.9 integr

Name of attribute:	**integr**
Description:	Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional:	No
Format:	Float
Domain Range:	0 – 1

E.3.23.2.10 revdate

Name of attribute:	**revdate**
Description:	Date of origination or last revision of data.
Optional:	No
Format:	Date

E.3.23.2.11 acn

Name of attribute:	**acn**
Description:	Parking stand location´s feasability for specific aircraft type according ICAO-ACN (Aircraft classification number)
Optional:	No
Format:	Character
Coding:	Aircraft type according ICAO-ACN (Aircraft classification number) for aircrafttypes painted on the apron. If there is more than one aircraft-type feasable for one parking stand location, the different types should be divided by a “.”. *Example for 747-400 and A 340 at one location: B744.A340*

E.3.24 Parking Stand Area

E.3.24.1 Parking Stand Area Feature Definition

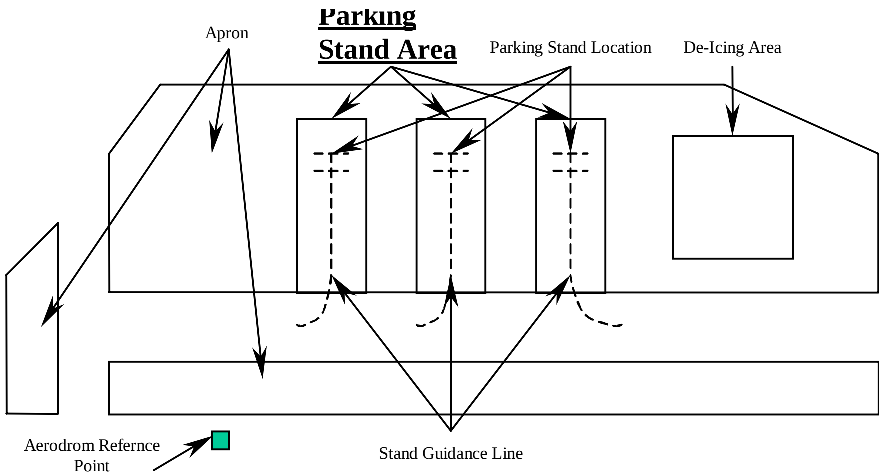


Figure E-30 Parking Stand Area Feature

Feature Name:	**Parking Stand Area**
Optional:	No
Description of Feature:	Operational area of parking stand. If no parking stand area painting is available, a virtual parking stand area should be provided.
Geometry Type:	Polygon
Derivation Method:	Calculated
Data capture rule:	Polygon covering the marked area on the apron surface used for a single aircraft as parking stand. If no parking stand area painting is available, a virtual parking stand area should provided under consideration of feasable aircraft wingspan and other applicable restrictions.

Attributes:

Name	Description
feattype	Parking Stand Area feature type
arptid	ICAO aerodrome location indicator
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of origination or last revision of data
material	Predominant surface type of the runway
pcn	Pavement classification number (pcn) of Parking Stand Area
jetway	Availability of Jetway
fuel	Types of fuel available
towing	Availability of towing service
docking	Availability of docking guidance system
gndpower	Availability of ground-power
standid	Object identifier

E.3.24.2 Parking Stand Area Attribute Definition

E.3.24.2.1 feattype

Name of attribute: **feattype**
Description: feature type
Optional: No
Format: Character
Fixed Value: "parking stand area"
Maximal Length: 32

E.3.24.2.2 arptid

Name of attribute: **arptid**
Description: ICAO aerodrome location indicator
Optional: No
Format: Character
Maximal Length: 5
Coding: ICAO aerodrome designator (4-letter code)
Example: KIAD

E.3.24.2.3 vacc

Name of attribute: **vacc**
Description: vertical accuracy of entity as a 95% LE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.24.2.4 hacc

Name of attribute:	**hacc**
Description:	horizontal accuracy of entity as a 95% CE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.24.2.5 vres

Name of attribute:	**vres**
Description:	vertical resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00–9.99

E.3.24.2.6 hres

Name of attribute:	**hres**
Description:	horizontal resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	Decimal Degrees
Domain Range:	0.00000001–0.001

E.3.24.2.7 source

Name of attribute:	**source**
Description:	Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional:	No
Format:	Character
Maximal Length:	50

E.3.24.2.8 integr

Name of attribute:	**integr**
Description:	Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional:	No
Format:	Float
Domain Range:	0 – 1

E.3.24.2.9 revdate

Name of attribute:	**revdate**
Description:	Date of origination or last revision of data.
Optional:	No
Format:	Date

E.3.24.2.10 material

Name of attribute: **material**
Description: Predominant surface type of Parking Stand Area
Optional: No
Format: Integer
Coding:

Code	Material
1	Concrete
2	Asphalt grooved
3	Desert/Sand
4	Bare earth
5	Snow/Ice
6	Water
7	Gras

Example for concrete: 1

E.3.24.2.11 pcn

Name of attribute: **pcn**
Description: Pavement classification number (pcn) of Parking Stand Area.
Optional: No
Format: Integer
Coding: Aircraft classification number – pavement classification number ACN-PCN. The format is specified in ICAO Annex 14, Chapter 2.6
Example: PCN80/R/B/W/T

E.3.24.2.12 jetway

Name of Attribute: **jetway**
Description: Availability of Jetway: available or not available
Optional: No
Format: Bool
Coding: available (1); not available (0)

E.3.24.2.13 fuel

Name of Attribute: **fuel**
Description: Types of fuel available
Optional: No
Format: Integer
Coding:

Code	fueltype
1	Jet A1
2	Avgas 100 LL
3	Mogas

E.3.24.2.14 towing

Name of Attribute: **towing**
Description: Availability of towing service: available or not available
Optional: No
Format: Bool
Coding: available (1); not available (0)

E.3.24.2.15 docking

Name of Attribute: **docking**
Description: Availability of docking guidance system: available or not available
Optional: No
Format: Bool
Coding: available (1) not available (0)

E.3.24.2.16 gndpower

Name of Attribute: **gndpower**
Description: Availability of ground-power: available or not available
Optional: No
Format: Bool
Coding: available (1); not available (0)

E.3.24.2.17 standid

Name of attribute: **standid**
Description: object identifier
Optional: No
Format: Character
Maximal Length: 15
Coding: Official parking stand ID
Example: V123

E.3.25 Deicing Area

E.3.25.1 Deicing Area Feature Definition

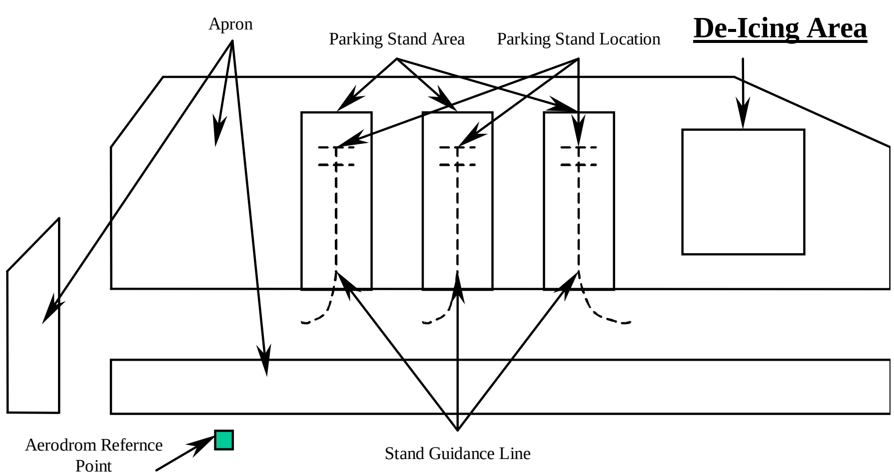


Figure E-31 Deicing Area Feature

Feature Name: **Deicing Area**
Optional: No
Description of Feature: Designated aircraft deicing area
Geometry Type: Polygon.
Derivation Method: Surveyed
Data capture rule: Polygon covering the marked deicing area on the apron surface.

Attributes:

Name	Description
feattype	Deicing area feature type
arptid	ICAO aerodrome location indicator
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of origination or last revision of data
material	Predominant surface type

E.3.25.2 Deicing Area Attribute Definition

E.3.25.2.1 feattype

Name of attribute: **feattype**
Description: feature type
Optional: No
Format: Character
Fixed Value: “deicing area”
Maximal Length: 32

E.3.25.2.2 arptid

Name of attribute: **arptid**
Description: ICAO aerodrome location indicator
Optional: No
Format: Character
Maximal Length: 5
Coding: ICAO aerodrome designator (4-letter code)
Example: KIAD

E.3.25.2.3 vacc

Name of attribute: **vacc**
Description: vertical accuracy of entity as a 95% LE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.25.2.4 hacc

Name of attribute:	**hacc**
Description:	horizontal accuracy of entity as a 95% CE
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00– 99.99

E.3.25.2.5 vres

Name of attribute:	**vres**
Description:	vertical resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00–9.99

E.3.25.2.6 hres

Name of attribute:	**hres**
Description:	horizontal resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	Decimal Degrees
Domain Range:	0.00000001-0.001

E.3.25.2.7 source

Name of attribute:	**source**
Description:	Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional:	No
Format:	Character
Maximal Length:	50

E.3.25.2.8 integr

Name of attribute:	**integr**
Description:	Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional:	No
Format:	Float
Domain Range:	0 – 1

E.3.25.2.9 revdate

Name of attribute:	**revdate**
Description:	Date of origination or last revision of data.
Optional:	No
Format:	Date

E.3.25.2.10 material

Name of attribute: **material**
Description: Predominant surface type of Deicing Area
Optional: No
Format: Integer
Coding:

Code	Material
1	Concrete
2	Asphalt
3	Desert/Sand
4	Bare earth
5	Snow/Ice
6	Gras

Example for concrete: 1

E.3.26 Aerodrome Reference Point

E.3.26.1 Aerodrome Reference Point Feature Definition

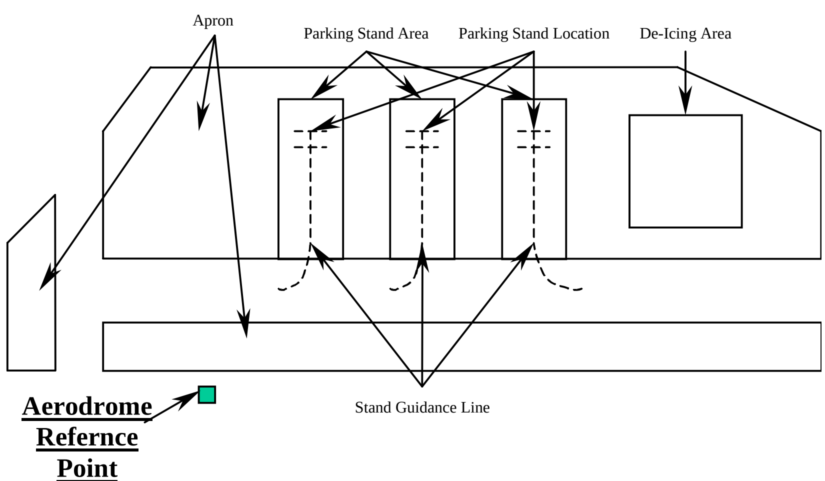


Figure E-32 Aerodrome Reference Point Feature

Feature Name: **Aerodrome Reference Point**
Optional: No
Description of Feature: The designated geographical location of an aerodrome (ICAO Annex 14, Chapter 1.1) as published in AIP.
Geometry Type: Point
Derivation Method: Calculated
Data capture rule: The designated geographical location of an aerodrome (ICAO Annex 14, Chapter 1.1) as published in AIP

Attributes:

Name	Description
feattype	Aerodrome Reference Point feature type
arptid	ICAO aerodrome location indicator
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of origination or last revision of data

E.3.26.2 Aerodrome Reference Point Feature Attribute Definition

E.3.26.2.1 feattype

Name of attribute: **feattype**
Description: feature type
Optional: No
Format: Character
Fixed Value: “aerodrome reference point”
Maximal Length: 32

E.3.26.2.2 arptid

Name of attribute: **arptid**
Description: ICAO aerodrome location indicator
Optional: No
Format: Character
Maximal Length: 5
Coding: ICAO aerodrome designator (4-letter code)
Example: KIAD

E.3.26.2.3 vacc

Name of attribute: **vacc**
Description: vertical accuracy of entity as a 95% LE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.26.2.4 hacc

Name of attribute: **hacc**
Description: horizontal accuracy of entity as a 95% CE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.26.2.5 vres

Name of attribute: **vres**
Description: vertical resolution of coordinates defining the feature
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00–9.99

E.3.26.2.6 hres

Name of attribute: **hres**
Description: horizontal resolution of coordinates defining the feature
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.26.2.7 source

Name of attribute: **source**
Description: Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional: No
Format: Character
Maximal Length: 50

E.3.26.2.8 integr

Name of attribute: **integr**
Description: Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional: No
Format: Float
Domain Range: 0 – 1

E.3.26.2.9 revdate

Name of attribute: **revdate**
Description: Date of origination or last revision of data.
Optional: No
Format: Date

E.3.27 Vertical Polygon Object

E.3.27.1 Vertical Polygon Object Feature Definition

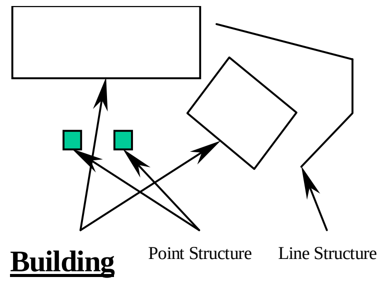


Figure E-33 Vertical Polygon Object Feature

Feature Name: Vertical Polygon Object
Optional: No
Description of Feature: Polygon structures that are located within a buffer of 50m from edge of aircraft movement zone (taxiways, runways, stopways, fato, apron, parking stand area, deicing area) or within the minimum separation distance specified in ICAO Document 9157, wichever is greater and which extend more than 0.5 meters above the horizontal plane passing through the nearest point on the aerodrom surface movement area are regarded vertical polygon objects. These may include objects like buildlngs, trees, earthen works, etc.
Geometry Type: Polygon
Derivation Method: Surveyed
Data capture rule: All fixed structures which fall in the buffer of a spatial extent as descibed above should be captured. In the horizontal plane a complex real worl object may consist of multiple polygons. In the vertical plane all polygons should be located on the highest point of the corresponding real-world object. The vertical polygon object features should be captured counter clockwise.

Attributes:

Name	Description
feattype	Vertical Polygon Objects feature type
arptid	ICAO aerodrome location indicator
objectid	Vertical Polygon Objects feature type identifier
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of origination or last revision of data
material	Predominant surface material
height	Maximal height of Vertical Polygon Object
elev	Maximal elevation of the top of Vertical Polygon Object (Orthometric elevation)

E.3.27.2 Vertical Polygon Object Attribute Definition

E.3.27.2.1 feattype

Name of attribute: **feattype**
Description: feature type
Optional: No
Format: Character
Fixed Value: “vertical polygon object”
Maximal Length: 32

E.3.27.2.2 arptid

Name of attribute: **arptid**
Description: ICAO aerodrome location indicator
Optional: No
Format: Character
Maximal Length: 5
Coding: ICAO aerodrome designator (4-letter code)
Example: KIAD

E.3.27.2.3 objectid

Name of attribute: **objectid**
Description: object identifier
Optional: No
Format: Integer

Coding:

Code	Type
1	Terminal Building
2	Hangar
3	Control Tower
4	Non-Terminal Building
5	Tank
6	Tree
7	Bush
8	Forest
9	Earthen works

E.3.27.2.4 vacc

Name of attribute: **vacc**
Description: vertical accuracy of entity as a 95% LE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.27.2.5 hacc

Name of attribute: **hacc**
Description: horizontal accuracy of entity as a 95% CE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.27.2.6 vres

Name of attribute: **vres**
Description: vertical resolution of coordinates defining the feature
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00–9.99

E.3.27.2.7 hres

Name of attribute: **hres**
Description: horizontal resolution of coordinates defining the feature
Optional: No
Format: Float
Units of Measurement: Decimal Degrees
Domain Range: 0.00000001–0.001

E.3.27.2.8 source

Name of attribute: **source**
Description: Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional: No
Format: Character
Maximal Length: 50

E.3.27.2.9 integr

Name of attribute: **integr**
Description: Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional: No
Format: Float
Domain Range: 0 – 1

E.3.27.2.10 revdate

Name of attribute: **revdate**
Description: Date of origination or last revision of data.
Optional: No
Format: Date

E.3.27.2.11 material

Name of attribute: **material**
Description: Predominant surface material of the Vertical Polygon Structure
Optional: No
Format: Integer
Coding:

Code	material
1	concrete
2	metal
3	stone/brick
4	composition
5	rock
6	earthen works
7	wood

E.3.27.2.12 height

Name of attribute: **height**
Description: Maximal height of top of Vertical Polygon Object
Optional: No
Derivation Method: surveyed
Format: Float
Units of Measurement: meters
Domain Range: 0.00 – 999.99

E.3.27.2.13 elev

Name of attribute:	**elev**
Description:	Maximal elevation of the top of Vertical Polygon Object (Orthometric elevation)
Optional:	No
Derivation Method:	surveyed
Format:	Float
Units of Measurement:	meters
Domain Range:	-500 – 9999.99

E.3.28 Vertical Point Object

E.3.28.1 Vertical Point Object Feature Definition

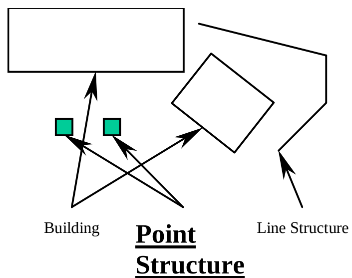


Figure E-34 Vertical Point Object Feature

Feature Name:	**Vertical Point Object**
Optional:	No
Description of Feature:	Structures that are located within a buffer of 50m (from edge of aircraft movement zone (taxiways, runways, stopways, fato, apron, parking stand area, deicing area) or within the minimum separation distance specified in ICAO Document 9157, wichever is greater and which extend more than 0.5 meters above the horizontal plane passing through the nearest point on the aerodrom surface movement area are regarded vertical point objects. These may include objects like poles, smokestacks, antennas, etc.
Geometry Type:	Point
Derivation Method:	Surveyed
Data capture rule:	All fixed structures which fall in the buffer of a spatial extent as descibed above should be captured. In the horizontal plane the vertical point object should be located in the center of the corresponding real-world object. In the vertical plane it should be located on the highest point of the real-world object.

Attributes:

Name	Description
feattype	Vertical Point Object feature type
arptid	ICAO aerodrome location indicator
objectid	Vertical Point Object feature type identifier
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data.
integr	Data integrity.
revdate	Date of origination or last revision of data.
material	Predominant surface material
height	Maximal height of feature
elev	Maximal elevation of the feature (Orthometric elevation)
lighting	Obstacle lighting in conformance with ICAO Annex 14, Chapter 6.2.
radius	Radius of circle around center of obstacle including body of obstacle and associated structures such as guywires.
marking	Obstacle marking in conformance with ICAO Annex 14, Chapter 6.2.

E.3.28.2 Vertical Point Object Attribute Definition

E.3.28.2.1 feattype

Name of attribute: **feattype**
Description: feature type
Optional: No
Format: Character
Fixed Value: “point object”
Maximal Length: 32

E.3.28.2.2 arptid

Name of attribute: **arptid**
Description: ICAO aerodrome location indicator
Optional: No
Format: Character
Maximal Length: 5
Coding: ICAO aerodrome designator (4-letter code)
Example: KIAD

E.3.28.2.3 objectid

Name of attribute: **objectid**
Description: object identifier
Optional: No
Format: Integer
Coding:

Code	Type
1	Smokestack
2	Powerline Pylon
3	Antenna
4	Windsock
5	Tree
6	Lightpole
7	Light stanchion

E.3.28.2.4 vacc

Name of attribute: **vacc**
Description: vertical accuracy of entity as a 95% LE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.28.2.5 hacc

Name of attribute: **hacc**
Description: horizontal accuracy of entity as a 95% CE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.28.2.6 vres

Name of attribute: **vres**
Description: vertical resolution of coordinates defining the feature
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00–9.99

E.3.28.2.7 hres

Name of attribute: **hres**
Description: horizontal resolution of coordinates defining the feature
Optional: No
Format: Float
Units of Measurement: Decimal Degrees
Domain Range: 0.00000001–0.001

E.3.28.2.8 source

Name of attribute:	**source**
Description:	Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional:	No
Format:	Character
Maximal Length:	50

E.3.28.2.9 integr

Name of attribute:	**integr**
Description:	Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional:	No
Format:	Float
Domain Range:	0 – 1

E.3.28.2.10 revdate

Name of attribute:	**revdate**
Description:	Date of origination or last revision of data.
Optional:	No
Format:	Date

E.3.28.2.11 material

Name of attribute:	**material**
Description:	Predominant surface material of Vertical Point Object
Optional:	No
Format:	Integer
Coding:	

Code	material
1	concrete
2	metal
3	stone/brick
4	composition
5	rock
6	wooden

E.3.28.2.12 height

Name of attribute:	**height**
Description:	Maximal height of top of point object
Optional:	No
Derivation Method:	surveyed
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00 – 999.99

E.3.28.2.13 elev

Name of attribute:	**elev**
Description:	Maximal elevation of top of point object (Orthometric elevation)
Optional:	No
Derivation Method:	surveyed
Format:	Float
Units of Measurement:	meters
Domain Range:	-500 – 9999.99

E.3.28.2.14 lighting

Name of Attribute:	**lighting**
Description:	Obstacle lighting in conformance with ICAO Annex 14, Chapter 6.2
Optional:	No
Format:	Bool
Coding:	conformant (1); non conformant (0)

E.3.28.2.15 radius

Name of attribute:	**radius**
Description:	Radius of circle around center of obstacle including body of obstacle and associated structures such as guywires.
Optional:	No
Derivation Method:	surveyed
Format:	Float
Units of Measurement:	meters
Domain Range:	0.00 – 999.99

E.3.28.2.16 marking

Name of Attribute:	**marking**
Description:	Obstacle marking in conformance with ICAO Annex 14, Chapter 6.2
Optional:	No
Format:	Bool
Coding:	conformant (1); non conformant (0)

E.3.29 Vertical Line Object

E.3.29.1 Vertical Line Object Feature Definition

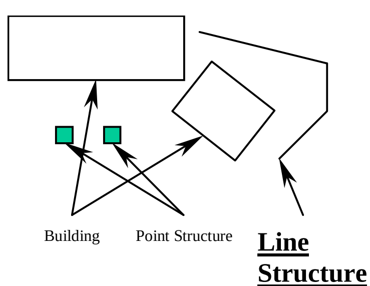


Figure E-35 Vertical Line Object Feature

Feature Name: **Vertical Line Object**
Optional: No
Description of Feature: Line structures that are located within a buffer of 50m (from edge of aircraft movement zone (taxiways, runways, stopways, fato, apron, parking stand area, deicing area) or within the minimum separation distance specified in ICAO Document 9157, wichever is greater and which extend more than 0.5 meters above the horizontal plane passing through the nearest point on the aerodrom surface movement area are regarded vertical line objects. These may include objects like power lines etc.
Geometry Type: Line
Derivation Method: Surveyed
Data capture rule: All fixed structures which fall in the buffer of a spatial extent as descibed above should be captured. In the horizontal plane the vertical line object should be located in the center of the corresponding real-world object. In the vertical plane it should be located on the highest point of the real-world object.

Attributes:

Name	Description
feattype	Vertical Line Object feature type
arptid	ICAO aerodrome location indicator
objectid	Vertical Line Object feature type identifier
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of origination or last revision of data
material	Predominant surface material
height	Maximal height of building
elev	Maximal elevation of the building (Orthometric elevation)
lighting	Obstacle lighting in conformance with ICAO Annex 14, Chapter 6.2
marking	Obstacle marking in conformance with ICAO Annex 14, Chapter 6.2

E.3.29.2 Vertical Line Object Attribute Definition

E.3.29.2.1 feattype

Name of attribute: **feattype**
Description: feature type
Optional: No
Format: Character
Fixed Value: “line object”
Maximal Length: 32

E.3.29.2.2 arptid

Name of attribute: **arptid**
Description: ICAO aerodrome location indicator
Optional: No
Format: Character
Maximal Length: 5
Coding: ICAO aerodrome designator (4-letter code)
Example: KIAD

E.3.29.2.3 objectid

Name of attribute: **objectid**
Description: object identifier
Optional: No
Format: Integer
Coding:

Code	Type
1	Power line
2	Cable railway

E.3.29.2.4 vacc

Name of attribute: **vacc**
Description: vertical accuracy of entity as a 95% LE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.29.2.5 hacc

Name of attribute: **hacc**
Description: horizontal accuracy of entity as a 95% CE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.29.2.6 vres

Name of attribute: **vres**
Description: vertical resolution of coordinates defining the feature
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00–9.99

E.3.29.2.7 hres

Name of attribute: **hres**
Description: horizontal resolution of coordinates defining the feature
Optional: No
Format: Float
Units of Measurement: Decimal Degrees
Domain Range: 0.00000001–0.001

E.3.29.2.8 source

Name of attribute: **source**
Description: Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional: No
Format: Character
Maximal Length: 50

E.3.29.2.9 integr

Name of attribute: **integr**
Description: Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional: No
Format: Float
Domain Range: 0 – 1

E.3.29.2.10 revdate

Name of attribute: **revdate**
Description: Date of origination or last revision of data.
Optional: No
Format: Date

E.3.29.2.11 material

Name of attribute: **material**
Description: Predominant surface material of Vertical Point Object
Optional: No
Format: Integer
Coding:

Code	material
1	concrete
2	metal
3	stone/brick
4	composition
5	rock
6	wood

E.3.29.2.12 height

Name of attribute: **height**
Description: Maximal height of top of line object
Optional: No
Derivation Method: surveyed
Format: Float
Units of Measurement: meters
Domain Range: 0.00 – 999.99

E.3.29.2.13 elev

Name of attribute: **elev**
Description: Maximal elevation of top of line object (Orthometric elevation)
Optional: No
Derivation Method: surveyed
Format: Float
Units of Measurement: meters
Domain Range: -500 – 9999.99

E.3.29.2.14 lighting

Name of Attribute: **lighting**
Description: Obstacle lighting in conformance with ICAO Annex 14, Chapter 6.2
Optional: No
Format: Bool
Coding: conformant (1); not conformant (0)

E.3.29.2.15 marking

Name of Attribute: **marking**
Description: Obstacle marking in conformance with ICAO Annex 14, Chapter 6.2
Optional: No
Format: Bool
Coding: conformant (1); non conformant (0)

E.3.30 Construction Area

E.3.30.1 Construction Area Feature Definition

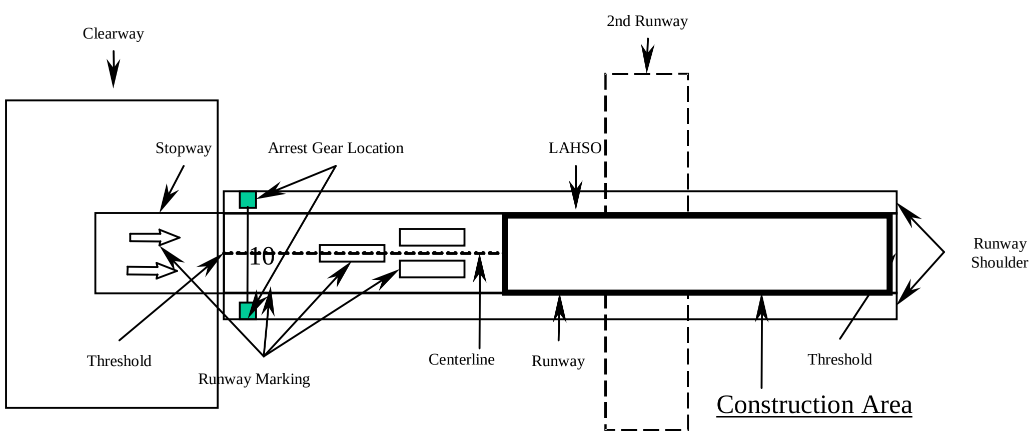


Figure E-36 Construction Area Feature

Feature Name: **Construction Area**
Optional: No
Description of Feature: Aircraft surface movement area under construction, including runways, taxiways, apron, aircraft parking stands, deicing area.
Geometry Type: Polygon
Derivation Method: Surveyed
Data capture rule: If assigned the outer edges of a marked area that is part of the surface movement area and under construction should be captured.
Attributes:

Name	Description
feattype	Construction Area feature type
arptid	ICAO aerodrome location indicator
hacc	Horizontal accuracy (as a 95% CE)
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of origination or last revision of data

E.3.30.2 Construction Area Feature Attribute Definition

E.3.30.2.1 feattype

Name of attribute: **feattype**
Description: feature type
Optional: No
Format: Character
Fixed Value: “construction area”
Maximal Length: 32

E.3.30.2.2 arptid

Name of attribute: **arptid**
Description: ICAO aerodrome location indicator
Optional: No
Format: Character
Maximal Length: 5
Coding: ICAO aerodrome designator (4-letter code)
Example: KIAD

E.3.30.2.3 hacc

Name of attribute: **hacc**
Description: horizontal accuracy of entity as a 95% CE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.30.2.4 hres

Name of attribute:	**hres**
Description:	horizontal resolution of coordinates defining the feature
Optional:	No
Format:	Float
Units of Measurement:	Decimal Degrees
Domain Range:	0.00000001–0.001

E.3.30.2.5 source

Name of attribute:	**source**
Description:	Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional:	No
Format:	Character
Maximal Length:	50

E.3.30.2.6 integr

Name of attribute:	**integr**
Description:	Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional:	No
Format:	Float
Domain Range:	0 – 1

E.3.30.2.7 revdate

Name of attribute:	**revdate**
Description:	Date of origination or last revision of data.
Optional:	No
Format:	Date

E.3.31 Survey Control Point

E.3.31.1 Survey Control Point Feature Definition

Feature Name:	**Survey Control Point**
Optional:	No
Description of Feature:	Location of monumented survey control points at the aerodrome surface (ICAO Doc 9674 WGS84 Manual, Chapter 5.2.5).
Geometry Type:	Point
Derivation Method:	Surveyed
Data capture rule:	The marked position of a survey control point should be captured.

Attributes:

Name	Description
feattype	Survey Control Point feature type
Arptid	ICAO aerodrome location indicator
vacc	Vertical accuracy (as a 95% LE)
hacc	Horizontal accuracy (as a 95% CE)
vres	Vertical resolution of coordinates defining the feature
hres	Horizontal resolution of coordinates defining the feature
source	Name of entity or organization that supplied data
integr	Data integrity
revdate	Date of origination or last revision of data
coord	Reference-Coordinates of Survey Point
hdate	Horizontal datum of reference coordinates
sheroid	Spheroid of reference coordinates
vdate	Vertical Datum of reference coordinates
project	Projection of reference coordinates

E.3.31.2 Survey Control Point Feature Attribute Definition

E.3.31.2.1 feattype

Name of attribute: **feattype**
Description: feature type
Optional: No
Format: Character
Fixed Value: “survey control point”
Maximal Length: 32

E.3.31.2.2 arptid

Name of attribute: **arptid**
Description: ICAO aerodrome location indicator
Optional: No
Format: Character
Maximal Length: 5
Coding: ICAO aerodrome designator (4-letter code)
Example: KIAD

E.3.31.2.3 vacc

Name of attribute: **vacc**
Description: vertical accuracy of entity as a 95% LE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.31.2.4 hacc

Name of attribute: **hacc**
Description: horizontal accuracy of entity as a 95% CE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.31.2.5 vres

Name of attribute: **vres**
Description: vertical resolution of coordinates defining the feature
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00–9.99

E.3.31.2.6 hres

Name of attribute: **hres**
Description: horizontal resolution of coordinates defining the feature
Optional: No
Format: Float
Units of Measurement: Decimal Degrees
Domain Range: 0.00000001–0.001

E.3.31.2.7 source

Name of attribute: **source**
Description: Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional: No
Format: Character
Maximal Length: 50

E.3.31.2.8 integr

Name of attribute: **integr**
Description: Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional: No
Format: Float
Domain Range: 0 – 1

E.3.31.2.9 revdate

Name of attribute: **revdate**
Description: Date of origination or last revision of data.
Optional: No
Format: Date

E.3.31.2.10 coord

Name of attribute:	**coord**
Description:	Reference-Coordinates of Survey Point as stated in authorized survey reports
Optional:	No
Format:	Character
Maximal Length:	32
Coding:	x/y/z-coordinates of survey reference point, separated by a “/”. *Example for Reference-Coordinates in UTM-Projection: 32499800.00/5500765.02/275.98*

E.3.31.2.11 hdate

Name of attribute:	**hdate**
Description:	Full name of horizontal datum of Reference-coordinates
Optional:	No
Format:	Integer
Maximal Length:	50

E.3.31.2.12 spheroid

Name of attribute:	**spheroid**
Description:	Spheroid of Reference Coordinate
Optional:	No
Format:	Integer
Maximal Length:	50

E.3.31.2.13 vdate

Name of attribute:	**vdate**
Description:	Name of vertical datum of reference coordinates.
Optional:	No
Format:	Character
Maximal Length:	32

E.3.31.2.14 project

Name of attribute:	**project**
Description:	Full name of Projection of Reference Coordinates.
Optional:	No
Format:	Character
Maximal Length:	32

E.3.32 Aerodrome Surface Lighting

E.3.32.1 Aerodrome Surface Lighting Feature Definition

Feature Name:	**Aerodrome Surface Lighting**
Optional:	Yes
Description of Feature:	Surface Lighting in or around aerodrome movement areas.
Geometry Type:	Point
Derivation Method:	Calculated
Data capture rule:	The center of lightning elements should be captured.

Attributes:

Name	Description
Feattype	Aerodrome Surface Lighting feature type
Arptid	ICAO aerodrome location indicator
Vacc	Vertical accuracy (as a 95% LE)
Hacc	Horizontal accuracy (as a 95% CE)
Vres	Vertical resolution of coordinates defining the feature
Hres	Horizontal resolution of coordinates defining the feature
Source	Name of entity or organization that supplied data
Integr	Data integrity
Revdate	Date of origination or last revision of data
Status	Status of Aerodrome Surface Lighting Element

E.3.32.2 Lighting Feature Attribute Definition

E.3.32.2.1 feattype

Name of attribute: **feattype**
Description: feature type
Optional: No
Format: Character
Fixed Value: “ASLE”
Maximal Length: 32

E.3.32.2.2 arptid

Name of attribute: **arptid**
Description: ICAO aerodrome location indicator
Optional: No
Format: Character
Maximal Length: 5
Coding: ICAO aerodrome designator (4-letter code) *Example: KIAD*

E.3.32.2.3 vacc

Name of attribute: **vacc**
Description: vertical accuracy of entity as a 95% LE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.32.2.4 hacc

Name of attribute: **hacc**
Description: horizontal accuracy of entity as a 95% CE
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00– 99.99

E.3.32.2.5 vres

Name of attribute: **vres**
Description: vertical resolution of coordinates defining the feature
Optional: No
Format: Float
Units of Measurement: meters
Domain Range: 0.00–9.99

E.3.32.2.6 hres

Name of attribute: **hres**
Description: horizontal resolution of coordinates defining the feature
Optional: No
Format: Float
Units of Measurement: Decimal Degrees
Domain Range: 0.00000001–0.001

E.3.32.2.7 source

Name of attribute: **source**
Description: Name of entity or organization that supplied data according RTCA DO 200A. In case of initial data origination, name of data originator.
Optional: No
Format: Character
Maximal Length: 50

E.3.32.2.8 integr

Name of attribute: **integr**
Description: Integrity of data in the aeronautical data processing chain from data origination process to present data manipulation process.
Optional: No
Format: Float
Domain Range: 0 – 1

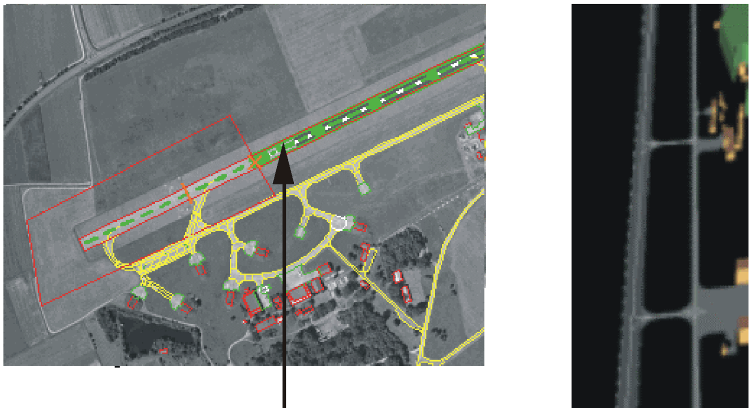
E.3.32.2.9 revdate

Name of attribute: **revdate**
Description: Date of origination or last revision of data.
Optional: No
Format: Date

E.3.32.2.10 status

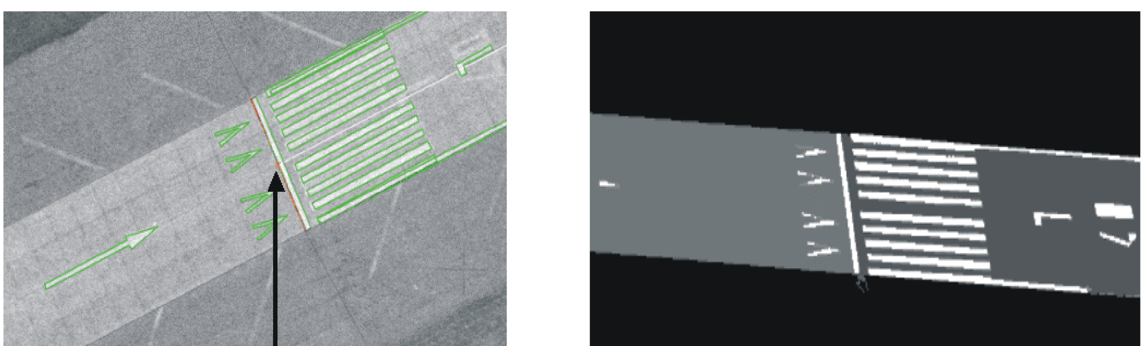
Name of Attribute: **status**
Description: Status of Aerodrome Surface Lighting Element at day of data generation or last revision: operative or inoperative.
Optional: No
Format: Bool
Coding: operative (1) or inoperative (0)

E.4 Examples



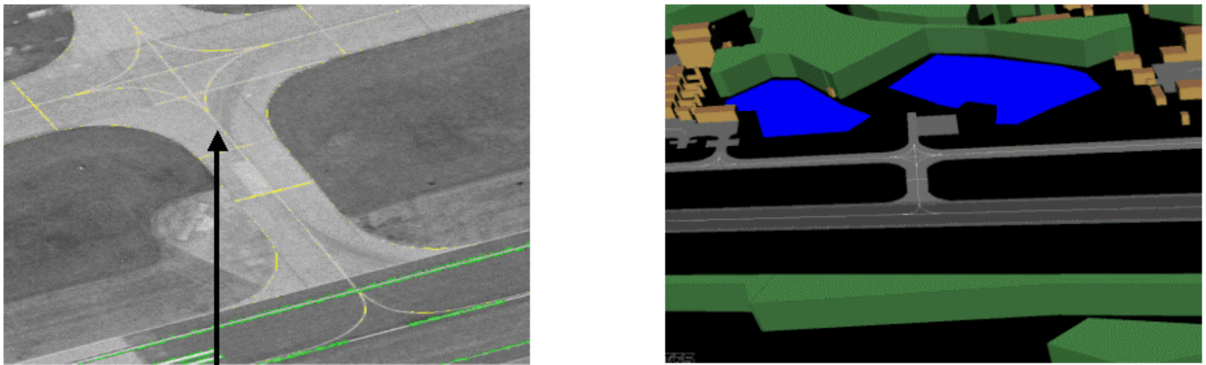
featid	arpid	rwyid	width	lenght	material	source	...
runway	EDDM	08L.26R	60	4000	2	TUD	...
runway	EDDM	08R.26L	60	4000	2	TUD	...

Figure E-37 Runway Feature Example



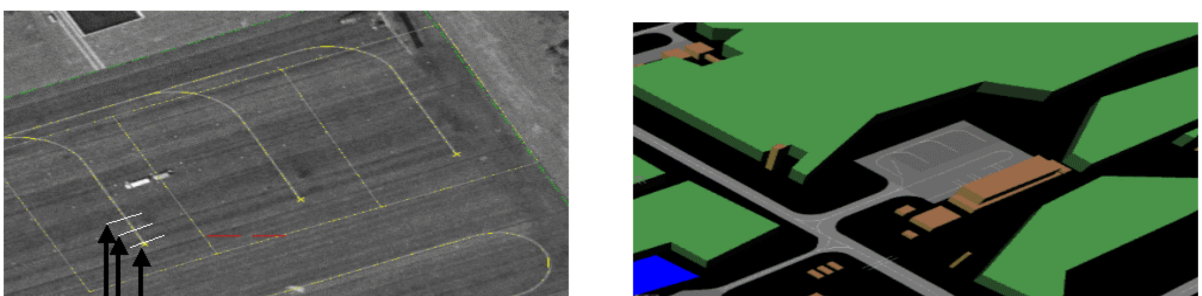
featid	aprtid	objectid	brngtrue	brngmag	papivasi	status	lda
threshold	EDDM	08L	083	083	1	0	4000
threshold	EDDM	26R	263	263	1	0	4000
threshold	EDDM	08R	083	083	1	1	4000
threshold	EDDM	26L	263	263	1	1	4000

Figure E-38 Threshold Feature Example



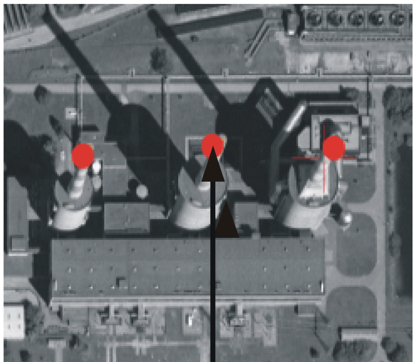
featid	arpid	objectid	direc	vacc	hacc	vres	hres
taxiway guidance line	EDDM	A	0	0.5	1.0	0.01	0.01
taxiway guidance line	EDDM	A	0	0.5	1.0	0.01	0.01
taxiway guidance line	EDDM	A	1	0.5	1.0	0.01	0.01

Figure E-39 Taxiway Guidance Line Example

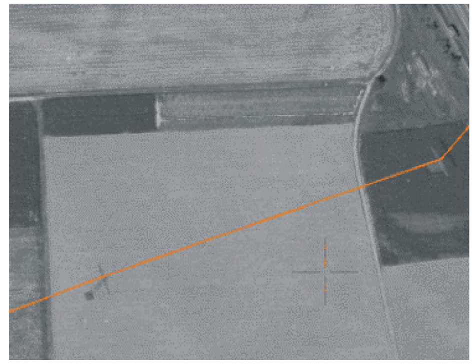


featid	arpid	objectid	source	acn	...
parking stand location	EDDM	A	TUD	F100	...
parking stand location	EDDM	A	TUD	B738	...
parking stand location	EDDM	A	TUD	A340.B744	...

Figure E-40 Parking Stand Location Example



Smokestacks (points)

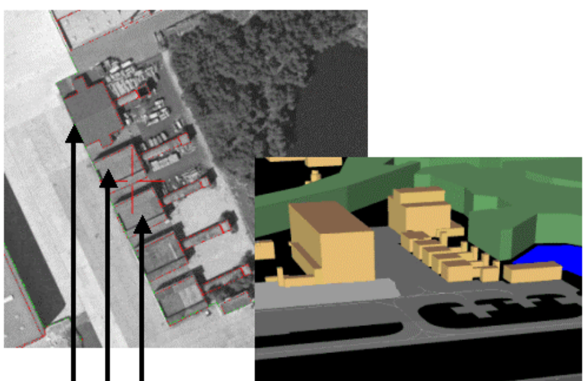


power lines (lines)

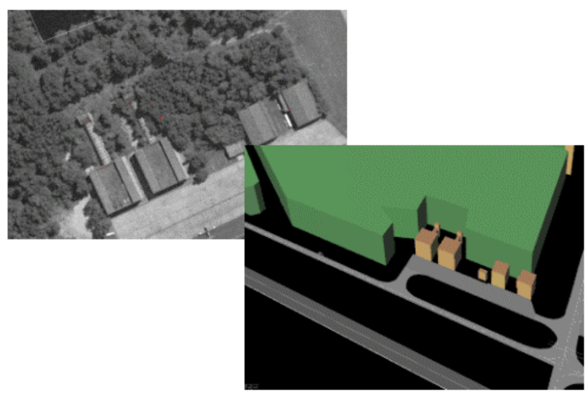
featid	arptid	objectid	height	elev	lighting	diameter
point structure	EDDM	541	21	351	1	12
point structure	EDDM	541	21	351	1	12
point structure	EDDM	541	22	353	1	12

15 attributes

Figure E-41 Vertical Point and Line Object Examples



buildings (polygons)



forests (polygons)

obstruction height (top)

obstruction elevation (top)

featid	arpid	objectid	material	status	height	elev
polygon structure	EDDM	953	6	0	21.40	320
polygon structure	EDDM	953	6	0	18.50	324
polygon structure	EDDM	953	6	0	4.50	321

11 attributes

Figure E-42 Vertical Polygon Object Feature

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Appendix F

MEMBERSHIP

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Appendix F—MEMBERSHIP

Joint RTCA Special Committee 193/EUROCAE WG-44

Terrain and Airport Databases

This document was written by a joint committee consisting of RTCA Special Committee 193 (SC-193) and EUROCAE Working Group 44 (WG-44). The primary authors of this document were in Sub-group 3 of this committee; their names are highlighted below.

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